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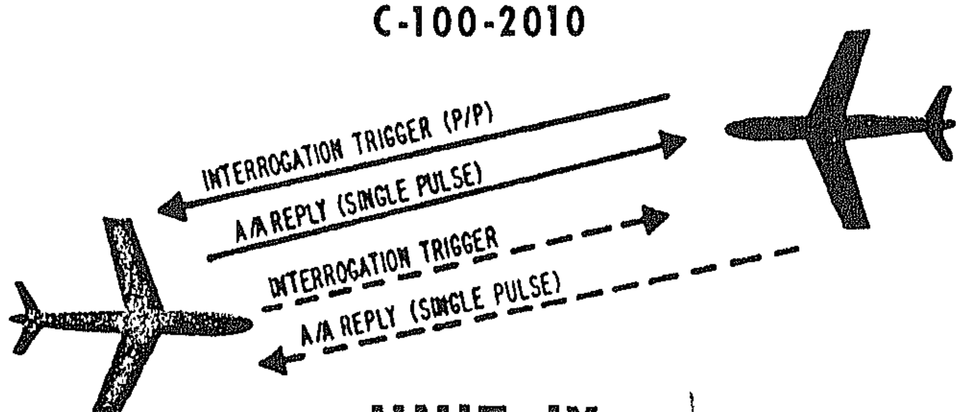
STUDENT WORKBOOK

FOR

ADVANCED FIRST-TERM AVIONICS COURSE

CLASS A1

C-100-2010



UNIT IX

AIR TO AIR TRANSMISSION

CNTT-M1707

PREPARED BY

NAVAL AIR TECHNICAL TRAINING CENTER

NAVAL AIR STATION MEMPHIS

MILLINGTON TENNESSEE

PREPARED FOR

CHIEF OF NAVAL TECHNICAL TRAINING

JUNE 1984

FOREWORD

The purpose of this Student's Workbook is to assist you through the Tactical Air Navigation Unit IX, of the Advanced First Term Avionics Course. The proper use of this guide will not only sharpen your knowledge of the TACAN system, but will also aid you in the lab with actual hands-on practical work, toward developing skills in eventually troubleshooting the TACAN trainer.

The table of contents lists the page numbers for safety notices, notetaking sheets, and references that will further enhance your abilities and skills as an electronics technician.

TABLE OF CONTENTS

SAFETY NOTICE

As a Navy electronics technician, you will be required to perform safe and efficient maintenance on various types of electronic equipment. Not only your life, but the lives of many others will depend on your being safety conscious at all times. It is the responsibility of all Navy and Marine Corps personnel to prevent accidents. This can be done if everyone develops conscientious safety habits and observes all precautions when performing for the Unit 9 lab are posted in the lab.

HOW TO USE THIS STUDENT'S WORKBOOK

This Student's Workbook has been prepared for you to use while you are attending the Advanced First-Term Avionics (A1) Course. Ample space has been provided for taking notes on the required lesson information. Remember when you are in class, the information being provided by your instructor is information you will need to satisfactorily complete this unit.

This volume contains the following:

1. Notetaking sheets, containing lesson topic outlines with illustrations and ample space for personal notetaking.

2. Information sheets to aid you in your learning effort.

3. Assignment sheets, which must be completed, to aid you in your understanding of the lessons in this unit.

4. Job sheets, to give you hands-on experience with the TACAN trainer and to aid in your learning effort.

UNIT IX CLASS SCHEDULE

Unit IX is ten days long and starts in the middle of the fifth day of the fifteenth week. The periods run from 597 to 676, with the last period finishing halfway through the fifth day of the seventeenth week.

The schedule is as follows:

TOPIC NO.	TYPE	PERIOD	TOPIC
FIFTEENTH WEEK			
First Day			
9.1	Class	597 598 599 600	Introduction to TACAN
SIXTEENTH WEEK			
First Day			
9.2	Class	601	Introduction to TACAN (Demo)
9.3	Lab	602 603 604	Introduction to TACAN
9.4	Class	605 606 607 608	Tacan Block Diagram Analysis
Second Day			
9.5	Class	609 610 611 612	Range Decoder Module Analysis
9.6	Lab	613 614 615 616	Range Decoder Module Analysis

TOPIC NO.	TYPE	PERIOD	TOPIC
Third Day			
9.7	Class	617 618	Air to Air Module Analysis
9.8	Class	619 620	RF Module Analysis
9.9	Class	621 622	Antenna Selector Module Analysis
9.10		623 624	TACAN Power Supplies
Fourth Day			
9.11	Class	625 626 627 628 629	Range A Module Analysis
9.12	Class	630 631 632	Range B Module Analysis
Fifth Day			
	Class	633	Unit/Module Test: Criterion Test/ Written Exam
		634	
9.13	Lab	635 636 637	Range A Module Analysis
9.14	Lab	638 639 640	Range B Module Analysis
SEVENTEENTH WEEK			
First Day			
9.15	Class	641 642	Bearing Decoder Module Analysis
9.16	Class	643 644 645 646	Bearing A and B Module Analysis
9.17	Lab	647 648	Bearing Decoder Module Analysis

TOPIC NO.	TYPE	PERIOD	TOPIC
Second Day			
9.18	Lab	649 650 651	Bearing A and B Module Analysis
9.19	Class	652 653 654 655 656	Troubleshooting a TACAN Unit
Third Day			
9.20	Lab	657 658 659 660 661 662 663 664	Troubleshooting a TACAN Unit
Fourth Day			
9.20	Lab	665 666 667 668 669	Troubleshooting a TACAN Unit
	Lab	670 671 672	Unit/Performance Test
Fifth Day			
	Class	673	Unit/Module Test: Criterion Test/Written Examination
		674 675 676	

UNIT V HOMEWORK SCHEDULE

All of the assignment sheets from 9.1.1A to 9.19.1A, are due the following day at the beginning of the lesson or period. The assignment sheets shall be turned in and will be checked by an instructor for completeness and correctness. Failure to turn in homework assignment could result in disciplinary action.

UNIT LEARNING OBJECTIVES

TERMINAL OBJECTIVE

13.0. ISOLATE an instructor-induced malfunction (under limited supervision) in an avionics TACAN training device to a weapons replaceable assembly, a shop replaceable assembly, a stage, and a component and RECORD results on job sheets. Test equipment will be provided. Performance must be accomplished in accordance with Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577. All general and personnel safety precautions must be observed, in accordance with OPNAVINST 5101.2 (series).

ENABLING OBJECTIVES

13.1. EXTRACT troubleshooting and performance data from given block and schematic diagrams of a TACAN training device. All circuit performance and operating characteristics will be documented on job sheets in accordance with specifications contained in Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

13.2. PERFORM visual inspections on an avionics TACAN training device for physical defects, security, integrity, and proper installation and RECORD results on a job worksheet. Performance must be accomplished in accordance with procedures outlined in the Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

13.4. ISOLATE an instructor-induced malfunction (under limited supervision) on an avionics TACAN training device to a weapons replaceable assembly, a shop replaceable assembly, a stage, and a component and RECORD results on job sheets. Test equipment will be provided. Performance must be accomplished in accordance with the Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

13.5. DOCUMENT, on the VIDS/MAF, all necessary corrective actions required, in a given maintenance situation, to restore an avionics, TACAN training device to an operational condition. Documentation must include the ordering and receipt of parts. All documentation must be legible and in accordance with OPNAVINST. 4790.2 (series).

NOTETAKING SHEET 9.1.1N

INTRODUCTION TO TACAN

REFERENCE:

Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

NOTETAKING OUTLINE:

A. TACAN ground station

1. Antenna

a. Vertically mounted marconi

(1) Physically

(2) Electrically

(3) Beam Pattern

b. Antenna reflector

(1)

(2) Beam pattern will be

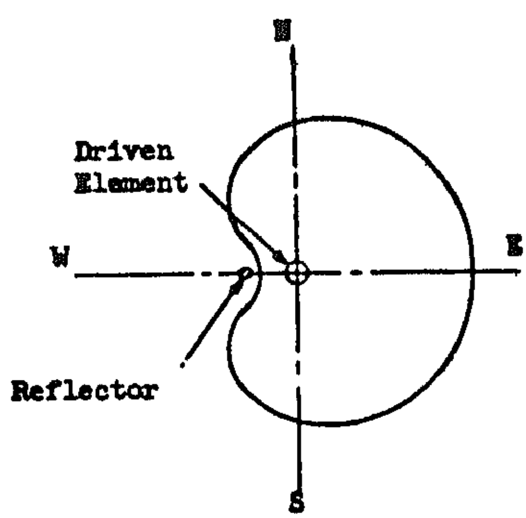


Figure 1

(3) The reflector is rotated

(a)

(b)

c. Antenna directors

(1)

(2) Nine directors

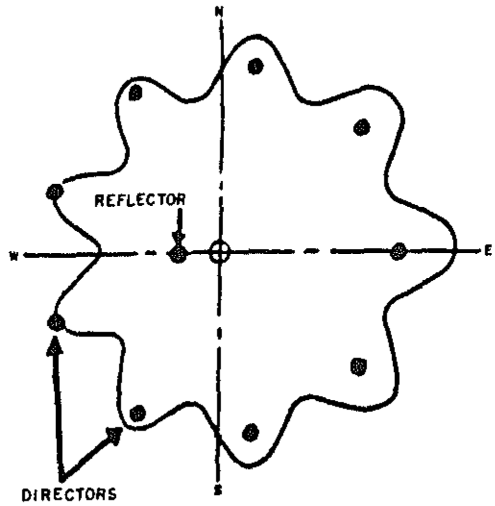


Figure 2

(3) The directors are rotated

2. TACAN reference pulses

a.

b. All TACAN pulses transmitted are pulse pairs.

(1) Pulse pair spacing is

(2) Pulse width is

(3)

(4)

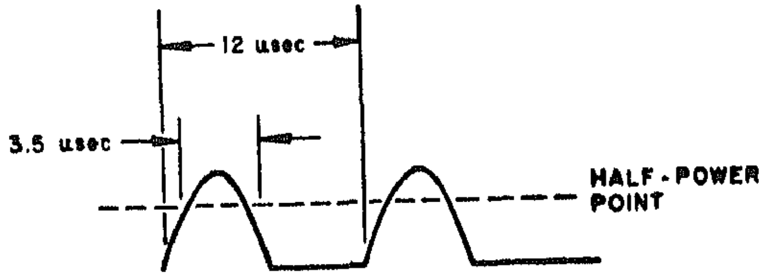


Figure 3

c. Main reference burst

(1)

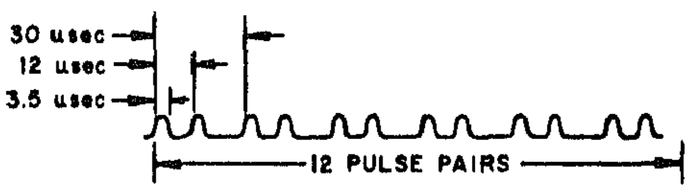


Figure 4

(2)

(3) Referred to as North reference burst, because it is referenced to magnetic North.

(4)

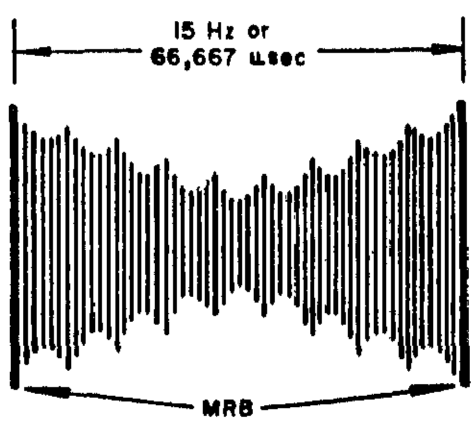


Figure 5

(5)

d. Auxiliary reference burst

(1)

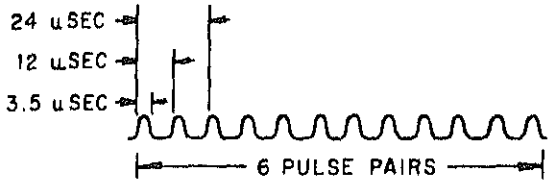


Figure 6

(2) Eight complete ARB's transmitted for ea antenna revolution.

(a)

(b)

(c)

(3) Time between ARB's

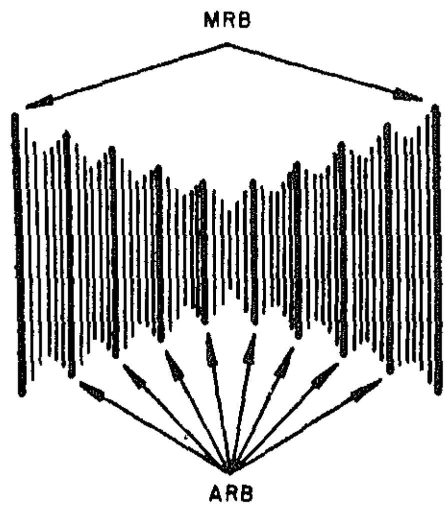


Figure 7

uitter pulses

)

(2)

(3)

f. Identification tone (I.D. tone)

(1)

(2)

(3)

g. Range reply

(1)

(2)

(3)

3. Sequence of TACAN pulse groups

a.

b.

c.

d.

e.

4. 3600 TACAN pulse pairs are transmitted per second.

a.

b.

c.

d.

B. Airborne Transceiver

1. Information provided to the pilot

a. Bearing

b. Slant range to the ground station.

c. ID tone

2. Modes of operation

   a. Off

   b. Receive (RCVR)

      (1)

      (2)

      (3)

   c. Transmit-Receive (TIR)

      (1)

         (a) Search -

         (b) Track -

      (2)

      (3)

   d. Air-to-Air (A/A)

      (1)

      (2)

3. Frequency Range

   a. 126 channels

b. 126 crystals

c. Frequency band is between 962 to 1213 MHz.

(1) Receive frequency range

(a) Low band -

(b) High band -

(2) Transmit frequency range

(a)

(b) Receive and transmit frequencies are 63 MHz apart.

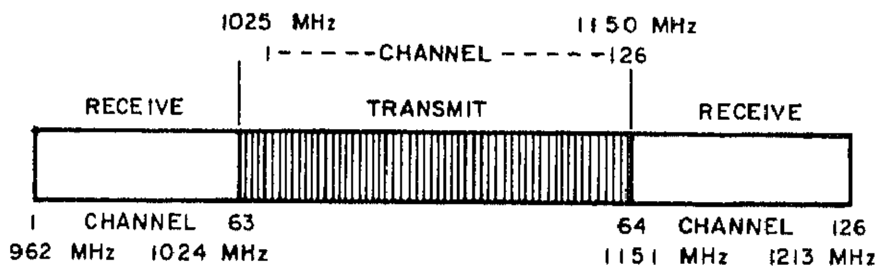


Figure 8

4. Operating specifications

a. Bearing accuracy -

b. Range accuracy -

c. Minimum receiver sensitivity

d. Minimum transmitter peak power -

e. Minimum warmup time -

C. TACAN Integrated Circuits

1. Comparator

a. Two possible input pins

(1)

(2)

b. To determine static output -

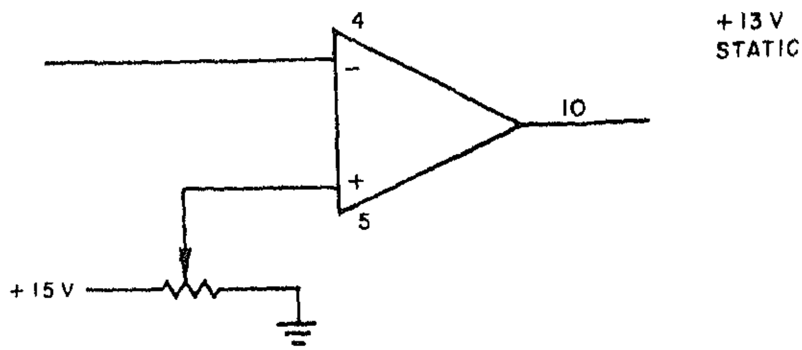


Figure 9

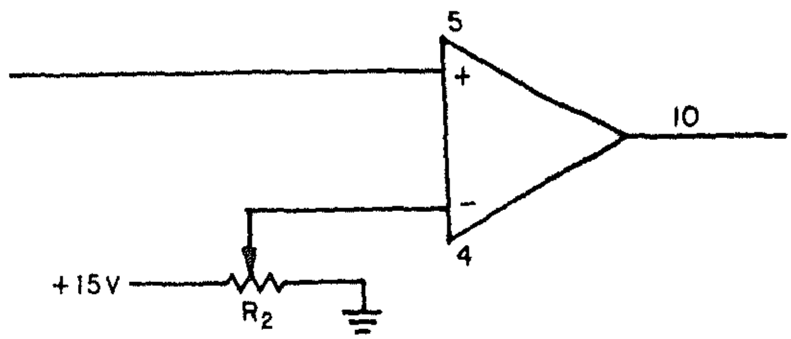


Figure 10

c. Input signal must overcome the reference voltage in order to switch the polarity of output.

(1)

(2)

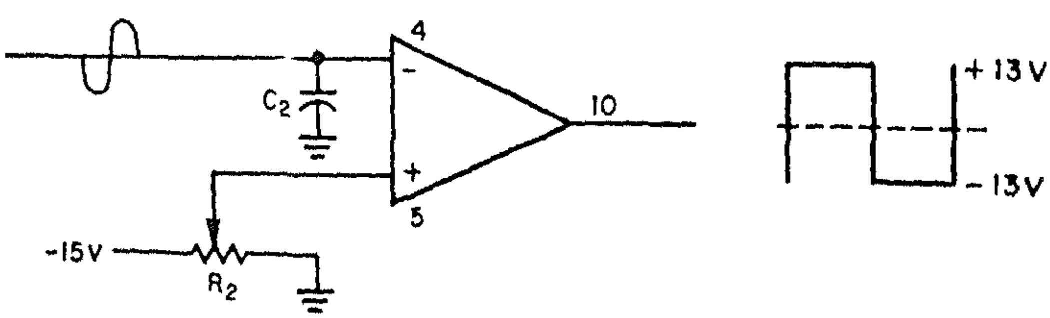


Figure 11

2. Operational amplifiers

   a. Input applied -

   b. Feedback applied -

   c. Gain determined by -

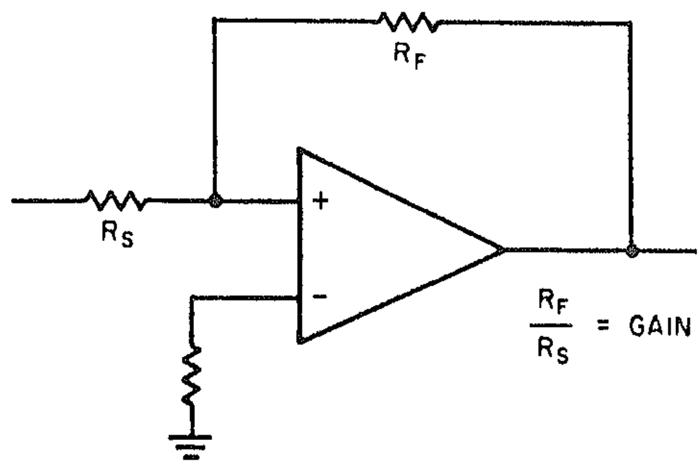


Figure 12

   d. Higher gain can be obtained by -

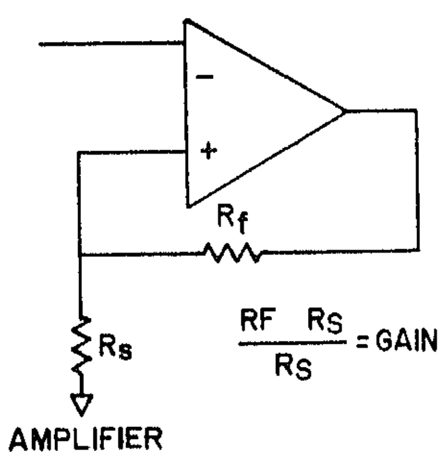


Figure 13

3. Active bandpass filters

   a. Input -

   b. Output -

(1) Fundamental -

(2) Harmonics -

(3) Variable resistor adjusts for center frequency

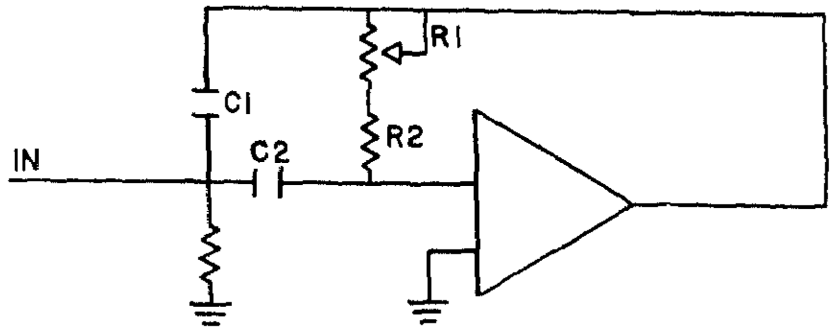


Figure 14

4. Crystal-controlled oscillator

   a.

   b.

   c.

5. Voltage follower

   a.

   b.

   c.

INFORMATION SHEET 9.1.1I

INTRODUCTION TO TACAN

INTRODUCTION

An understanding of the TACAN system operation requires that the individual modules, and the interaction of the modules as a system, be thoroughly understood. The purpose of this information sheet is to provide you with a short glossary and an insight into the system theory of TACAN.

REFERENCES

TACAN SYSTEMS MAINTENANCE TRAINER, DEVICE 8H7, Maintenance Handbook with Parts List, NAVTRADEV P-3577

INTEGRATED CIRCUITS AND SEMICONDUCTOR DEVICES: Theory and Application; DEBOO/BURROUS; McGraw-Hill, 1977; pp. 115-174

"INTRODUCTION TO A TACAN SYSTEM N-5A"; NATTC, CNATT-M-204(Rev 1-72) Pat

"INTRODUCTION TO A TACAN SURFACE STATION N-5B"; NATTC, CNATT-M205 (Rev.1-72) Pat

INFORMATION

GLOSSARY

AMPLITUDE MODULATION - Modulation in which the amplitude of a wave is the characteristic subject to variation.

PULSE MODULATION - The use of a series of pulses modulated to convey information/modulation of a carrier by a train of pulses.

STANDARD TACAN PULSE PAIR - Two pulses, 3.5 microseconds at their half-power points, that are spaced 12 microseconds apart.

MAIN REFERENCE BURST (MRB) - TWELVE standard TACAN Pulse Pairs with 30 microsecond spacing between pulse pairs.

AUXILIARY REFERENCE BURST (ARB) - Six standard TACAN Pulse Pairs with 24 microsecond spacing between pulse pairs.

SQUITTER PULSES - Random filler pulse pairs from the station to maintain a constant duty cycle of 3600 pulse pairs per second.

TACAN (Tactical Air Navigation) is a radio air navigation system of the polar-coordinate type. It provides a properly equipped aircraft with bearing and distance information from a ground station selected by the pilot. This system incorporates 126 two-way operating channels, spaced 1 MHz apart, within an operating band of 962 to 1213 MHz. The airborne unit transmits on a selected frequency between 1025 and 1150 MHz and the ground station transmits on a selected frequency between 962 to 1024 or 1151 to 1213 MHz.

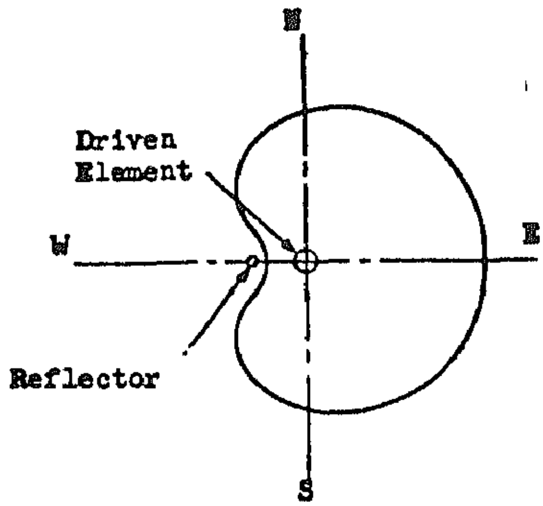
The ground station can receive on any one of 126 frequencies in the range of 1025 to 1150 MHz. Low band installations transmit at frequencies from 962 to 1024 MHz. High band installations transmit at frequencies from 1151 to 1213 MHz. Two frequencies are used for each channel, one for receiving and one for transmitting. In high band installations the receiving frequency is 63 MHz below the transmitting frequency. In low band installations the receiving frequency is 63 MHz above the transmitting frequency.

The range from the ground station is visually displayed in the aircraft on a meter calibrated in nautical miles. Another meter indicates direction in degrees, with respect to magnetic north, that the pilot must fly to get to the selected ground station.

In Range operation the airborne transmitter repeatedly sends out interrogation pulse pairs that are received by the ground station which in turn triggers the associated transmitter to send out reply pulse pairs at the same PRF. The reply pulse pairs are picked up by the airborne receiver. Timing circuits automatically measure the interval between the interrogation and reply pulse pairs and convert this time interval into electrical signals that operate the Range Indicator. Bearing information is supplied by amplitude modulating the train of pulse pairs generated by the ground station transmitter; modulation is generated by the antenna equipment.

The ground station provides a means through which the position of an aircraft can be accurately determined. As many as 100 aircraft may simultaneously obtain Range information from a single TACAN installation due to the random PRF of the airborne unit transmitter.

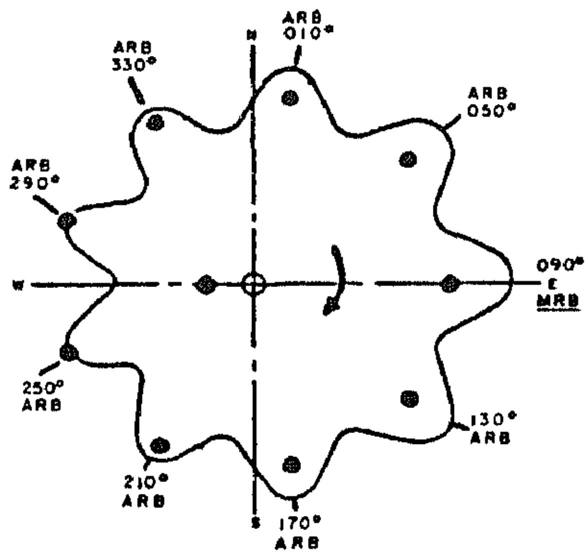
Bearing reference groups are transmitted by the ground station to provide phase reference for the bearing information signals. Two types of reference groups are provided. Coarse bearing reference groups, called Main Reference Bursts, are transmitted from the ground station when the major lobe is radiated east (090°) from the station at a 15 Hz rate. (See Fig. #1.) This group consists of 12 pulse pairs spaced 30 microseconds apart.



Beam Pattern of A Vertically Mounted Marconi Antenna

Figure 1

Fine bearing reference groups, called Auxiliary Reference Burst, are transmitted from the ground station every 40° after the Main Reference Burst (see Fig. #2).



ARB
Figure 2

This group consists of six pulse pairs, spaced 24 microseconds apart.

Bearing information signals are derived from amplitude modulation of the signal pulses. Modulation is achieved by rotating a shaped radiating pattern around the transmitting antenna at a 15 Hz rate (900 rpm). The rotation of the pattern causes a variation in signal strength at any point that appears as amplitude modulation. The radiation pattern is such that the modulation envelope is a 15 Hz sine wave with a super imposed 135 Hz sine wave riding on it (see Fig. 3).

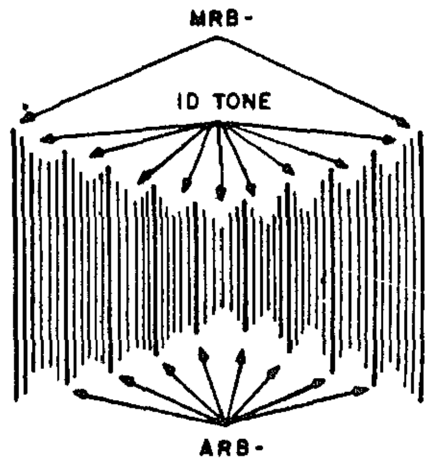


Figure 3 - ARB with ID Tone

The phase of the amplitude modulation being received by the aircraft is dependent on the position of the aircraft in respect to a surface station. The TACAN unit compares the time occurrence of the MRB with the phase of the 15 Hz modulation and converts the difference into coarse bearing information. The unit also compares the time occurrence of the ARB with the phase of the 135 Hz modulation and converts the difference into fine bearing information.

The ground station periodically transmits its identifying signal in International Morse Code; thus, enabling the aircraft to determine which ground station it is in contact with. The characters of the code pulse modulate the carrier at a fixed rate of 1350 Hz. A mechanical keyer accomplishes the coding. The aircraft receiver detects these regularly occurring pulse pairs and reproduces the code as a 1350 Hz audio tone. Identification signals have priority over Range Replies but due to the short occurrence time of the ID Tone (every 37.5 seconds), they will not interrupt range information.

INTEGRATED CIRCUITS

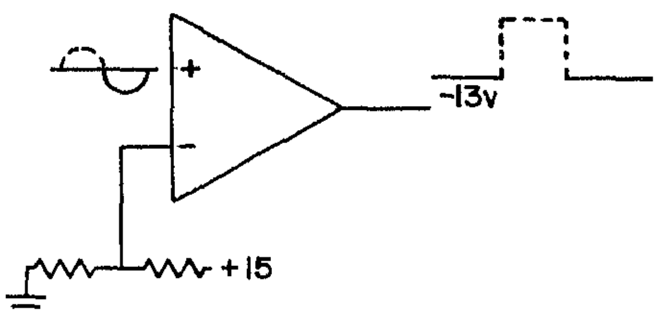
The use of IC's in electronic equipment offers the following advantages:

1. Improved cost/performance ratio.
2. Improved reliability.
3. Reduced space and weight.
4. Good thermal tracking due to the close spacing of components on the same chip.

The integrated circuit has become one of the most versatile and widely employed devices in electronics. The prime features that make op-amps so desirable include a circuit performance that is very predictable, a high input impedence, a wide range of obtainable gain values and the ability to amplify a d-c as well as an a-c signal.

COMPARATORS

The integrated circuit is represented by a specific symbol with two inputs marked + and -. The - terminal is called the inverting input and the + terminal is called the non-inverting input. A reference level is normally established on the non-signal input pin to establish a static operating level at the output of the comparator. The incoming signal must overcome the reference level in order to switch the output level (see Fig. 4).



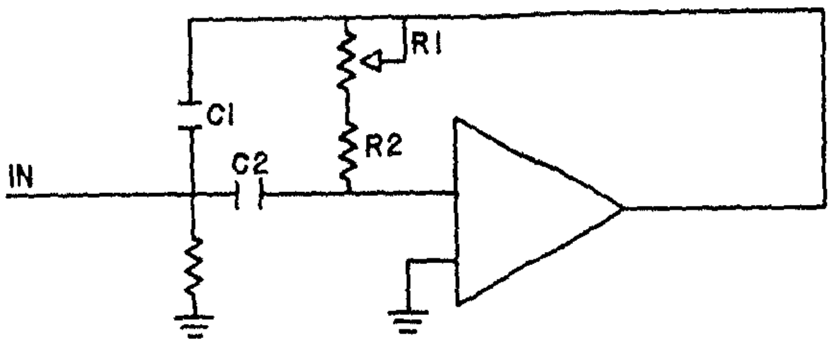
Comparator

Figure 4

No feedback is employed, so that the circuit operates with full gain. In the 8H7 Trainer, a 709 IC Chip is normally used as the comparator device and it has an output that switches from either a +13 to a -13 V d-c or -13 to a +13 V d-c Comparators are widely used in such applications which require level detection, such as analog-to-digital converters, digital-to-analog convertors, time-to-voltage convertors and zero-crossing detectors.

ACTIVE FILTERS

Active filters are filters that employ passive elements in conjun tion with active elements to obtain characteristics similiar to L filters. (see Fig. 5)

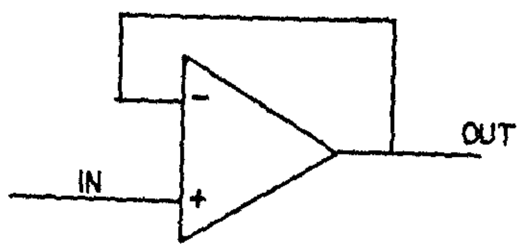


Active Filter

Figure 5

The circuit is basically a voltage follower with a frequency determining network (adjustable by R1) in the feedback network. This circuit will remove all subharmonics of the incoming waveform leaving only the desired frequency to be sent to the next stage.

VOLTAGE FOLLOWERS

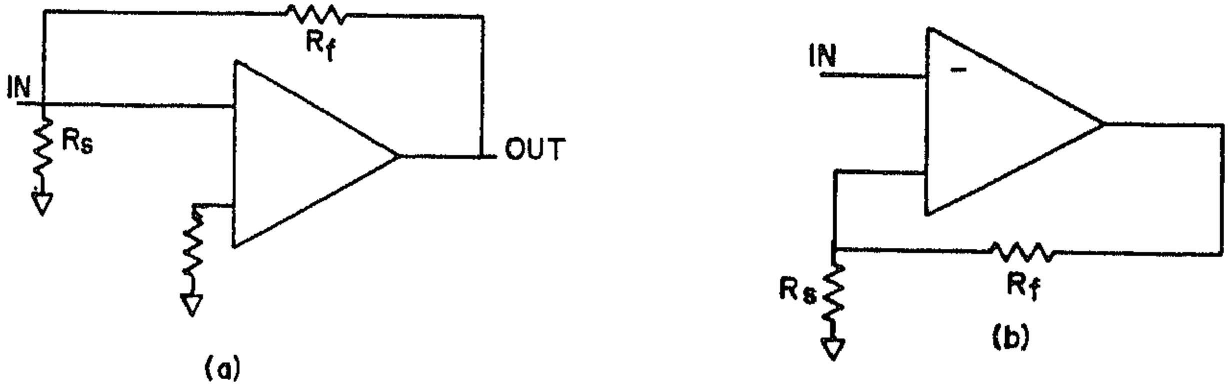


Voltage Follower

Figure 6

(see Fig. 6) No feedback components are used, but there is a feedback connection from the output to the inverting input, which causes the gain of the circuit to be unity. This circuit has a high input and a low output impedence, which makes it ideal for use as an impedence transformer similiar to emitter followers.

IC operational amplifiers have a very large open loop gain which when operated in a closed loop condition will cause the gain to be smaller than the open loop gain. (see Fig. 7)



Operational Amplifiers

Figure 7

Gain in this configuration is determined by dividing the feedback resistance (Rf) by the shunt resistance (Rs) or $\frac{Rf}{Rs} = \text{Gain}$.

This circuit is known as an inverting amplifier. Using the same components as in Fig. 7a a slightly different configuration will create a non-inverting amplifier with a higher gain. (see Fig. 7b) Gain is now figured by using the following formula $\frac{Rf+Rs}{Rs} = \text{Gain}$.

This circuit is a more general version of the voltage follower circuit in which $Rs=\infty$ and $Rf = 0$.

TACAN SYSTEM ANALYSIS

ASSIGNMENT SHEET 9.1.1A

INTRODUCTION

The purpose of this assignment sheet is to familiarize you with the operation of the entire TACAN system so that the signal flow inside the airborne unit will be easier to understand.

LESSON TOPIC LEARNING OBJECTIVES

13.1.1. SELECT, from a given list, the TACAN airborne and surface station transmit and receive frequencies.

13.1.2. SELECT, from a given list, the two types of modulation and their uses in the TACAN system.

13.1.3. SELECT, from a given list, the pulse width, spacing and purpose, of a standard TACAN pulse pair.

13.1.4. SELECT, from a given list, the frequency and repetition rate of the ID Tone.

13.1.5. SELECT, from a given list, the PRF of the TACAN transmitter in the search and track modes.

13.1.6. SELECT, from a given list, the purpose of rotating one parasitic reflector and nine parasitic directors around the antenna at 900 rpm.

13.1.7. SELECT, from a given list, the frequency of the MRB and ARB.

13.1.8. SELECT, from a given list, the number and spacing of the pulses in an MRB and ARB.

13.1.9. SELECT, from a given list, the purpose of the random squitter pulse pairs.

13.1.10. SELECT, from a given list, the total number of pulse pairs per second transmitted by a TACAN surface station.

13.1.11. Given an illustration of an operational amplifier used in the TACAN trainer, COMPUTE the gain.

13.1.12. SELECT, from a given list, the type of integrated circuit that correctly identifies a given illustration.

STUDY ASSIGNMENT

1. Study Information Sheet 9.1.1I.

6. The auxiliary reference burst is transmitted every __________ degrees after the main reference burst.

   a. 40
   b. 90
   c. 50
   d. 270

7. How many times is the auxiliary reference burst transmitted per antenna revolution?

   a. 12
   b. 8
   c. 6
   d. 15

8. The main reference burst is transmitted

   a. 900 per minute
   b. 199 per minute
   c. 120 to 150 per minute
   d. 22 to 30 per second

9. The spacing of the pulses in a pulse pair is

   a. 12 μs
   b. 3 1/2 μs
   c. 24 μs
   d. .00012 ms

10. The pulse width of a pulse in a pulse pair is

   a. 3 1/2μs @ 1/2 power points
   b. 3 1/2 μs
   c. 12 μs @ 1/2 power points
   d. 12 μs

11. Of the 3600 pps transmitted, how many are used for azimuth information?

   a. 2700
   b. 3600
   c. 900
   d. 135

12. How many parasitic elements are used to produce the 135 Hz variable bearing signal?

   a. 1
   b. 8
   c. 15
   d. 9

2. Complete Programmed Instruction N-5A, "Introduction to a TACAN System."

3. Complete Programmed Instruction N-5B, "Introduction to a TACAN Surface Station."

4. Complete Assignment Sheet 9.1.1A.

5. Review Notetaking Sheet 9.1.1N.

STUDY QUESTIONS

1. The surface beacon station operates at a constant duty cycle o approximately

   a. 3600 pps.
   b. 2700 pps.
   c. 120 to 150 pps.
   d. 22 to 33 pps.

2. The main reference burst is transmitted when the major lobe passes

   a. magnetic east.
   b. magnetic north.
   c. true north.
   d. true east.

3. The spacing between pulse pairs in the main reference burst is

   a. 30 μs.
   b. 12 μs.
   c. 8 μs.
   d. 24 μs.

4. The pulse pair spacing of the auxiliary reference burst is

   a. 30μs.
   b. 12μs.
   c. 8μs.
   d. 24μs.

5. How many pulse pairs are in the main reference burst?

   a. 22 to 30
   b. 120 to 150
   c. 8
   d. 12

6. The auxiliary reference burst is transmitted every ________ degrees after the main reference burst.

a. 40
b. 90
c. 50
d. 270

7. How many times is the auxiliary reference burst transmitted per antenna revolution?

a. 12
b. 8
c. 6
d. 15

8. The main reference burst is transmitted

a. 900 per minute
b. 199 per minute
c. 120 to 150 per minute
d. 22 to 30 per second

9. The spacing of the pulses in a pulse pair is

a. 12 μs
b. 3 1/2 μs
c. 24 μs
d. .00012 ms

10. The pulse width of a pulse in a pulse pair is

a. 3 1/2μs @ 1/2 power points
b. 3 1/2 μs
c. 12 μs @ 1/2 power points
d. 12 μs

11. Of the 3600 pps transmitted, how many are used for azimuth information?

a. 2700
b. 3600
c. 900
d. 135

12. How many parasitic elements are used to produce the 135 Hz variable bearing signal?

a. 1
b. 8
c. 15
d. 9

13. The surface beacon station uses what type of modulation?

a. AM and FM
b. Pulse and RF
c. Pulse and amplitude
d. Amplitude and RF

14. The frequency spectrum of the TACAN system is

a. 1025 to 1150 MHz
b. 962 to 1213 MHz
c. 962 to 1024 MHz
d. 1151 to 1213 MHz

15. The surface beacon station can supply range information to how many aircraft simultaneously?

a. 195
b. 299
c. 3600
d. 100

16. What is the frequency of the ID pulses transmitted by the beacon station?

a. 135 Hz
b. 1350 Hz
c. 2700 Hz
d. 3600 Hz

17. What types of information are available by the use of the TACAN system?

a. Range and azimuth
b. Azimuth and ID tone
c. Range azimuth and ID tone
d. MRB, ARB, Range, ID tone and squitters

18. The frequency range of the airborne transmitter is

a. 962 to 1024 MHZ
b. 962 to 1213 MHZ
c. 1151 to 1213 MHz
d. 1025 to 1150 MHz

19. The frequency range of the airborne receiver is

a. 962 to 1024 MHz and 1151 to 1213 MHz
b. 962 to 1213 MHz
c. 962 to 1108 MHZ and 1109 to 1213 MHz
d. 1025 to 1150 MHz

20. How many channels are available in the TACAN transceiver?

a. 135
b. 126
c. 120
d. 4

21. How many crystals are used to make these channels available?

a. 15
b. 136
c. 126
d. 115

22. In order to display range and azimuth information, the FUNCTION SELECTOR switch must be in the

a. OFF position.
b. RCVR position.
c. T/R position.
d. A/A position.

23. The maximum range of the TACAN system is

a. 2000 miles.
b. 135 miles.
c. 50,000 feet.
d. 300 miles.

24. The bearing accuracy of the TACAN is

a. 2/9°.
b. 5.0°.
c. 0.5°.
d. 9/2°.

25. The range accuracy is

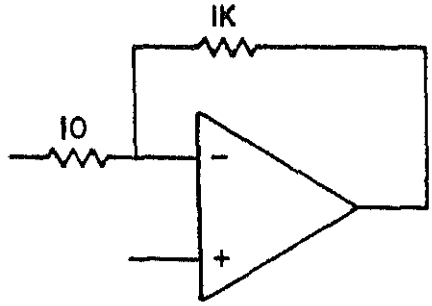
a. 2.0 miles.
b. 0.5 miles at 300 miles.
c. 5.0 miles at 300 miles.
d. 9/2 miles.

26. The TACAN is operating on channel 56.

a. The airborne transmitter frequency is ____________.
b. The airborne receiver frequency is ____________.
c. The beacon transmitter frequency is ____________.
d. The beacon receiver frequency is ____________.

27. Determine the value required in the following IC's:

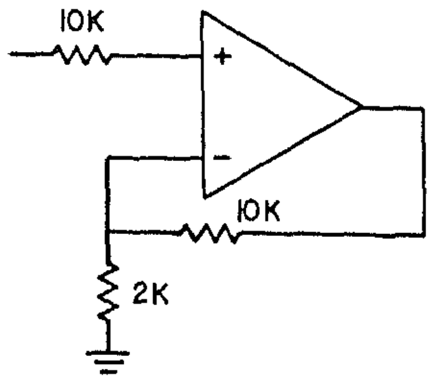
a.



gain = ________

Figure 1

b.



gain = ________

Figure 2

c. Draw the output signal

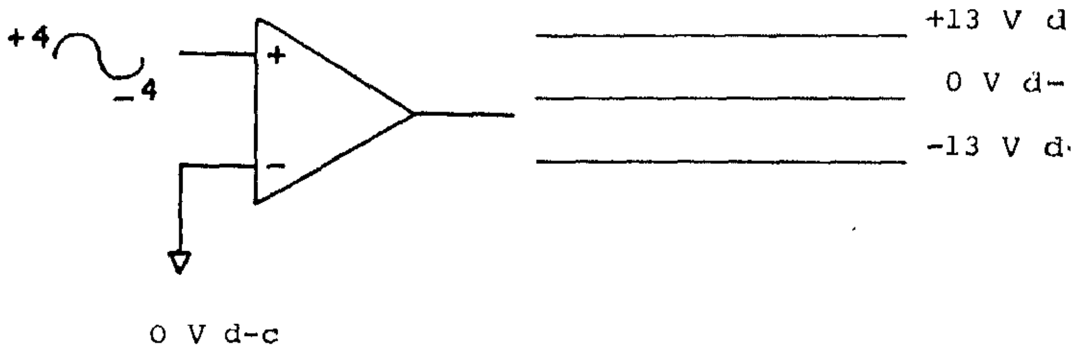


Figure 3

INFORMATION SHEET 9.2.1I

TACAN TEST EQUIPMENT SETUP

INTRODUCTION

In order to complete the upcoming labs and troubleshoot the 8H7 TACAN trainer, you must know how to properly set up the appropriate test equipment, and do a complete operational check. This information sheet is provided to help you accomplish this task.

REFERENCE

Maintenance Handbook with Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

INFORMATION

A. Preliminary Setup Procedures

1. Oscilloscope 453 - Turn the power switch ON

2. Beacon Simulator AN/ARM-22A

   a. Ensure the antenna cable is connected from J704 on the signal generator to the antenna jack J5 on the 8H7 Trainer.

   b. Turn the AC and DC Power Switches on the power supply to ON.

   c. Turn the Power Switch on the signal generator to ON.

3. Preliminary inspection of the Beacon Simulator and TACAN trainer.

   a. Ensure ALL modules are properly installed and none are missing.

   b. Ensure Simulator interconnection cables are in place:

      (1) J705 PULSE MOD IN to J6 MOD OUT

      (2) J708 INTERR OUT to J303 RANGE IN

      (3) J314 RANGE OUT to J3 RANGE IN

      (4) J706 SQ PULSE IN to J18 SQ PULSE OUT

   c. Turn the POWER SWITCH to ON and the MODE SWITCH to RCVR position on the TACAN control panel.

B. STANDBY PROCEDURES (Use only when removing circuit boards)

1. Remove scope probe from test point.

2. Place TACAN MODE and POWER switches to the OFF position.

3. All other POWER switches should be left ON for STANDBY.

C. SECURE PROCEDURES

1. Turn ALL power and mode switches to OFF Position

2. Replace all boards in proper positions

D. SAFETY

1. Watches, rings, tie clips, and any other metal jewelry wil be removed.

2. Ensure the two metal tabs on top of each board are NEVER left in the raised position to prevent injury to yourself and others.

3. Ensure both MODE and POWER switches on the control panel are OFF before removing or replacing any module or extender.

4. DO NOT place TACAN MODE switch in T/R or A/A positions until you are sure TACAN power supply has timed out.

5. Dangerous voltages are present in this equipment. Use caution and observe standard safety rules to prevent injuries.

E. OPERATIONAL PROCEDURE for Type 453 Oscilloscope

1. TURN-ON procedure

a. Cathode ray tube controls

(1) INTENSITY: mid-range
(2) FOCUS: midrange
(3) SCALE: fully CCW

b. Vertical controls (both A and B channels)

(1) VOLTS/DIV: .5 volts
(2) VARIABLE: CAL.
(3) POSITION: midrange
(4) INPUT COUPLING: AC
(5) MODE: Channel to be used
(6) TRIGGER: NORMAL
(7) INVERT: pushed in

c. Triggering controls (both A and B channels)

(1) LEVEL: CW(+)
(2) SLOPE: +
(3) COUPLING: AC
(4) SCOURCE: EXT ÷ 10

d. SWEEP Controls

(1) DELAY TIME MULTIPLIER: fully CCW
(2) A & B TIME/DIV: 5msec
(3) A VARIABLE: CAL
(4) B SWEEP MODE: B STARTS AFTER TIME DELAY
(5) HORIZ DISPLAY: A
(6) MAG: OFF
(7) A SWEEP LENGTH: FULL
(8) A SWEEP MODE: NORM TRIGGER
(9) POSITION: midrange

2. Setup for waveform analysis (Ch 1 or Ch 2 when appropriate)

a. VOLTS/DIV: as required
b. A & B TIME/DIV: as required
c. SYNCH INPUT from J5 on PULSE GENERATOR
d. LEVEL: as required to get stable sweep on oscilloscope.

F. OPERATIONAL PROCEDURES FOR BEACON SIMULATOR (AN/ARM-22A)

1. Initial control settings

a. SG-317A/ARM-22 (Pulse Generator)

(1)	SPACING	12(microseconds)
(2)	POS-NEG	POS
(3)	MOD-UNMOD	MOD
(4)	PULSE OUTPUT	SQUITTER RANGE
(5)	15 HZ AMP ADJUST	WHERE MARKED
(6)	135 HZ AMP ADJUST	WHERE MARKED
(7)	SYNC SELECTOR	15 HZ

b. SM-142A/ARM-22A (Range and Azimuth Simulator)

(1)	RANGE	FIXED
(2)	FIXED RANGE	0
(3)	EFFICIENCY	85%
(4)	AUX BURST	AUX BURST(ON)
(5)	NORTH BURST	NORTH BURST (ON)
(6)	BEARING MOTOR	BEARING MOTOR (ON)
(7)	BEARING DIAL	270
(8)	15 HZ PHASE SHIFT	0
(9)	135 HZ-OFF-REV	135 HZ (up)
(10)	15 HZ-OFF-REV	15 HZ (up)
(11)	BEARING RATE	MAX CCW
(12)	RANGE RATE	MAX CCW
(13)	DIAL DRIVE	OFF

c. SG-318A/ARM-22

(1)	RF LEVEL DBM	-50 dBm
(2)	NORMAL- A/A	NORMAL
(3)	ARN-21 POWER	MAX CW
(4)	CHANNEL	63 or 64

2. CALIBRATION OF SG-318A/ARM-22 (SIGNAL GENERATOR)

a. Place FUNCTION SEL in ZERO position.
b. Press and hold PUSH TO SET button.
c. Turn Zero Set control to adjust meter reading to zero.
d. Release the PUSH-TO-SET button.
e. Place the FUNCTION SEL switch in the SG POWER CALIBRATOR position.
f. Press and hold the PUSH-TO-SET button.
g. Using the recessed SG POWER CALIBRATOR control, adjust the POWER LEVEL meter to the SET line with a screwdriver.
h. Release the PUSH-TO-SET button.
i. Place the FUNCTION SEL switch in the PULSE OUT position. On the PULSE GENERATOR place the MOD-UNMOD switch in the UNMOD position.
j. Press and hold the PUSH-TO-SET button.
k. Press firmly in and adjust the RF TRIM control for a peak on the POWER LEVEL meter. It may be necessary to adjust the OUTPUT SET control to put this reading in a workable range on the meter.
l. Adjust the OUTPUT SET control until the POWER LEVEL meter reads on the SET line.
m. Release the PUSH-TO-SET button.
n. Place the MOD-UNMOD switch on the PULSE GENERATOR in the MOD position.
o. Repeat steps a through n once; then continue.

NOTE: CALIBRATION IS REQUIRED FOR ANY CHANNEL CHANGE THAT IS MADE. CALIBRATION SHOULD BE RECHECKED AFTER 15 MINUTES OF OPERATION.

G. OPERATIONAL CHECK OF A TACAN SYSTEM

1. Setup for operational check

a. Perform preliminary setup and operational procedures.
b. Set the CHANNEL SELECTOR on the control panel to channel 63 or 64. (Must be the same channel as that previously selected on the signal generator)
c. Check TACAN input:
   (1) Connect an oscilloscope probe from CH1 or CH2 input on the oscilloscope to test point J1-3 on the 1A1A1 board (RDM)

(2) A TACAN composite waveform should be observed at this time. Adjust the oscilloscope as follows for one cycle of the observed signal:

(a) Adjust LEVEL control to show stable presentation with an MRB at the beginning of the sweep by adjusting the control slowly CCW.
(b) Adjust the A & B TIME/DIV VARIABLE (center red knob) to show and MRB or ARB under each line of the oscilloscope screen.
(c) Adjust A SWEEP LENGTH to show only nine divisions of the display.
(d) This procedure will be used to check the input to the TACAN TRAINER for each lab and to show one cycle of the COMPOSITE WAVEFORM. If at this time there is no modulation on waveform, recheck to see that STEP F.2.0 was accomplished. (Calibration of SG-318A/Arm-22)

TABLE I: OPERATIONAL PROCEDURES: TACAN SYSTEM 8H7

STEP	INITIAL CONDITION/PROCEDURES	NORMAL INDICATIONS
a.	AZIMUTH ACCURACY AND TRACKING	
	(1) Observe azimuth indication	Azimuth indicator should lock on to a bearing of 270 degrees +/- 2 degrees
	(2) Place the DIAL DRIVE switch in the CW position	
	(3) Turn the BEARING RATE control slowly to the 5th division	Azimuth indicator should smoothly track the changing bearing
NOTE:	THIS SIMULATES THE AZIMUTH CHANGING AT A RATE OF 20 DEGREES PER SECOND, WHICH IS THE MINIMUM STANDARD FOR AZIMUTH TRACKING	
	(4) Place the DIAL DRIVE switch in the CCW position	
	(5) Set the BEARING RATE control fully CW	Indications same as in Step 3
	(6) Place the DIAL DRIVE switch in the OFF position	
	(7) Set the bearing to 270 degrees	Indications same as step 1

b. RANGE ACCURACY AND TRACKING

(1) Set the TACAN MODE selector switch to the T/R position	The range indicator should lock on to 0 miles +/- 0.5 miles, which would indicate good range accuracy
(2) Place the RANGE switch in the 0 to 50 position	The range indicator should lock on to some range between 0 and 55 miles
(3) Turn the RANGE RATE control CW to the 5th division	The range indicator should track in and out between approximately 0 and 55 miles, which checks the TACAN range tracking capability

NOTE: THIS SIMULATES A RANGE CHANGE AT A RATE OF 2500 KNOTS

(4) Set the RANGE RATE control fully CCW	
(5) Place the RANGE switch in the FIXED position	Indications same as Step 1
(6) Set the TACAN MODE switch to the RCVR position	

---

c. ID TONE TEST

(1) Plug headset into AUDIO IDENTITY jack on the CONTROL PANEL	
(2) Turn the ID VOLUME control CW	An ID RINGING TONE should be heard in the headset
(3) Place the PULSE OUTPUT selector switch on the pulse generator (SG-317A) in the TONE position	A DIFFERENCE should be heard in the tone, normally a more steady and clear tone can be heard
(4) Turn the ID VOLUME fully CCW and return the PULSE OUTPUT SELECTOR switch to the SQUITTER RANGE position and secure the headset	

---

d. AIR-TO-AIR OPERATION

(1) Set PULSE OUTPUT selector switch to A/A low

(2) Place the NORMAL-A/A switch (on the SG-318A) to the A/A position

(3) Set the TACAN MODE switch to the A/A position — The RANGE INDICATOR should lock on to the fixed range selected (0, 18, 36) +/- 0.5 miles. The AZIMUTH INDICATOR should search CCW.

(4) Place the PULSE OUTPUT selector switch to the SQUITTER RANGE position

(5) Place the NORMAL-A/A switch to the NORMAL position

(6) Set the TACAN MODE switch to the T/R position

---

e. RECEIVER SENSITIVITY

(1) Set the SG-318A RF LEVEL DBM dial to the -80 position — Both indicators should stay locked on to their previous readings. If indicators fail to stay locked on, proceed to the note before continuing.

(2) Set the SG-318A RF LEVEL DBM dial to the -50 position.

NOTE: IF indicators locked on at -50 dBm, and not at -80 dBm, then the lowest level that lock on can be achieved must be found in order to measure the sensitivity. Starting at -50 lower the RF LEVEL DBM dial SLOWLY until either indicator breaks lock on. REMEMBER that both the range and bearing have a 10 second memory time. IF either RANGE or BEARING checked bad in the previous checks, the sensitivity may still be checked by using the indications that checked good. Example: If RANGE was abnormal, only the Bearing could still be used to check sensitivity.

f. TRANSMITTER PEAK POWER

(1) Place the FUNCTION SELECTOR switch to the ARN/21 POWER position.

(2) Ensure that the ARN/21 POWER CONTROL is fully CW to prevent meter damage.

(3) Press and hold the PUSH-TO-SET button and turn the ARN/21 POWER CONTROL CCW until the POWER LEVEL meter reads on the SET line.

TACAN peak power output is read off the ARN/21 POWER CONTROL, it should read a minimum of 1.5kW.

NOTE: YOU ARE CHECKING TACAN TRANSMITTER POWER, SO THE TACAN MODE SELECTOR SWITCH MUST BE IN THE T/R POSITION.

(4) Release the PUSH-TO-SET button

(5) Turn the ARN/21 POWER CONTROL fully CW.

(6) Return the FUNCTION SELECTOR switch to the PULSE OUT position.

(7) At this point if you are not doing a range lab or troubleshooting a range problem, place mode switch in RCVR position.

JOB SHEET 9.3.1J

INTRODUCTION TO A TACAN UNIT

INTRODUCTION

This job sheet will provide you with the guidance required to conduct a minimum performance check on the 8H7 TACAN trainer. You will also observe how the composite waveform peak changes phase with a change in bearing. This lab will also have you expand and display the MRB and an ARB. It is to your benefit that you complete this lab successfully, because part of your performance test will come from this.

ENABLING OBJECTIVES

13.2.1 RECORD, in the student workbook provided, the chassis module layout.

13.3.1 Physically DEMONSTRATE the ability to operate the test equipment used with a TACAN system, by following specified guidelines while being monitored in the laboratory.

13.3.2 DEMONSTRATE the ability to perform an operational check on a TACAN system by following specified guidelines and recording appropriate indications in the student workbook provided.

13.3.3 DETERMINE the bearing, by observing and recording, in the student workbook provided, output waveforms from the simulator.

13.3.4 RECOGNIZE the different types of signals contained in a composite waveform by listing them in the student workbook provided and labeling each with its proper name.

REFERENCE:

Maintenance Handbook with Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

EQUIPMENT AND MATERIALS:

1. Job Sheet 9.3.1J

2. Information Sheet 9.2.1I

3. AN/ARM-22A Radio Test Set

4. Type 453 Oscilloscope with 10:1 probe.

5. 8H7 TACAN Training Device

6. Straight Slot Screwdriver

PRECAUTIONS TO BE OBSERVED:

1. 1800 V d-c in R-F Module.

2. When extending a module, the metal lock tabs must remain down at all times.

3. Remove only the 4 small coax cables on the simulator, NOTHING ELSE.

4. No test point readings will be taken on the backside of the module.

5. Plastic cover over the power supply must always remain down.

6. Do not check or remove any fuses.

7. Standby and Secure procedures are listed on Information Sheet 9.2.1I.

8. Do not place TACAN mode switch in T/R until the TACAN power supply has timed out (90 seconds).

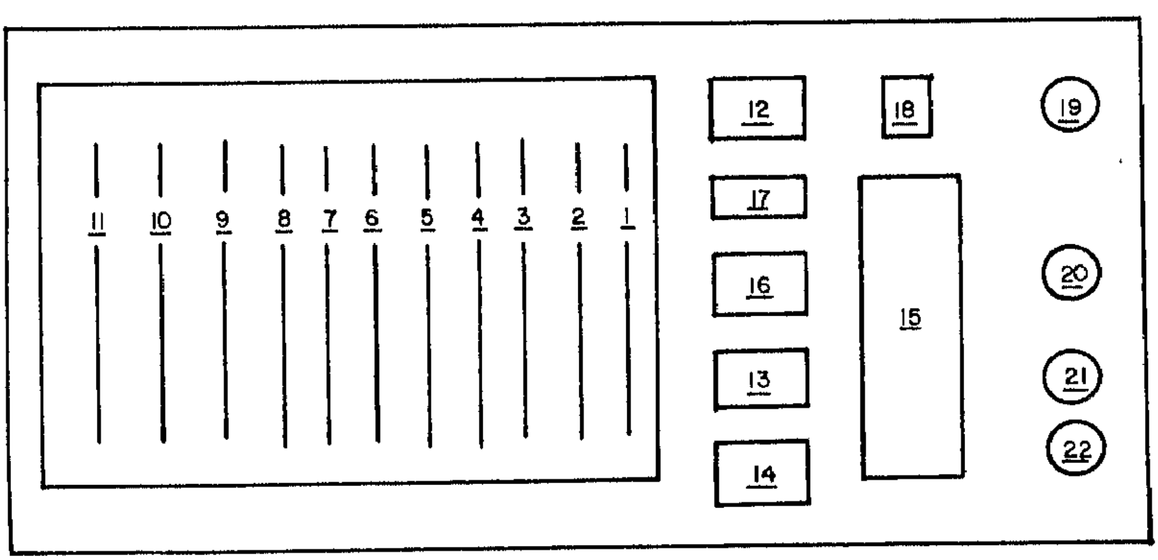
9. No jewelry will be worn in the lab.

PROCEDURE:

NOTE: Do not apply power to simulator or trainer until step 2.

1. Location of equipment parts and subassemblies - Identify the subassemblies and parts below by name and number.

	NAME	
1.	______________________________	1A1A ________
2.	______________________________	1A1A ________
3.	______________________________	1A1A ________
4.	______________________________	1A1A ________
5.	______________________________	1A1A ________
6.	______________________________	1A1A ________
7.	______________________________	1A1A ________
8.	______________________________	1A1A ________
9.	______________________________	1A1A ________
10.	______________________________	1A1A ________
11.	______________________________	1A1A ________
12.	______________________________	1A1A ________
13.	______________________________	1A1A ________
14.	______________________________	1A1A ________
15.	______________________________	1A1A ________
16.	______________________________	1A1A ________
17.	______________________________	1A1A ________
18.	______________________________	J-________
19.	______________________________	J-________
20.	______________________________	J-________
21.	______________________________	J-________
22.	______________________________	J-________



MODULE LAYOUT
Figure 1

2. TACAN operational check
   a. Set up the oscilloscope, the ARM-22A simulator and perfor the operational check listed on Information Sheet 9.2.1I and record the results in the spaces provided below:

	NORMAL	ABNORMAL
(1) Azimuth accuracy and tracking	( )	( )
(2) Range accuracy and tracking	( )	( )
(3) ID tone	( )	( )
(4) Air-to-air simulation	( )	( )
(5) Receiver sensitivity	( )	( )
(6) Transmitter peak power	( )	( )

NOTE: After completion of the operational check, leave the equipment on, and continue to the next step. Leave th azimuth indicator pointing to 270 degrees.

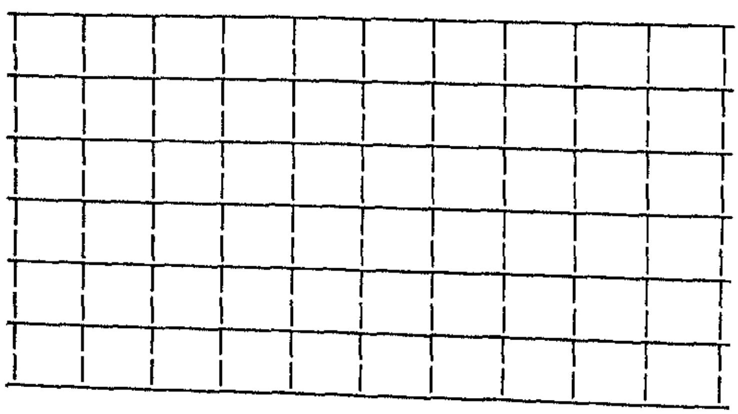
3. Receiver waveform analysis

NOTE: All waveforms will be taken with the "O"scope set for one cycle of the TACAN composite waveform, unless otherwise noted.

   a. Connect signal probe from scope to J1-3 (1A1A1) of the RDM.

   b. Set the VOLT/DIV control to .5 volts.

   c. Set the bearing dial to read 270°, and record the waveform in the space provided below, also answer questior 1-3 listed below.



(1) Describe the observed waveform composition.

(a) ______________________________

(b) ______________________________

(c) ______________________________

(d) ______________________________

(e) ______________________________

(f) ______________________________

(g) ______________________________

(2) The peak of the observed signal, in relationship to the MRB, is

INPHASE/LEADING/LAGGING by ________ degrees.

(3) Select the correct statement(s) that refer to the waveform in step 3c.

(a) The aircraft's position is 270° from the simulated station.

(b) Maximum power is directed toward 090° when the MRB is transmitted.

(c) The aircraft's position is magnetic East of the simulated station.

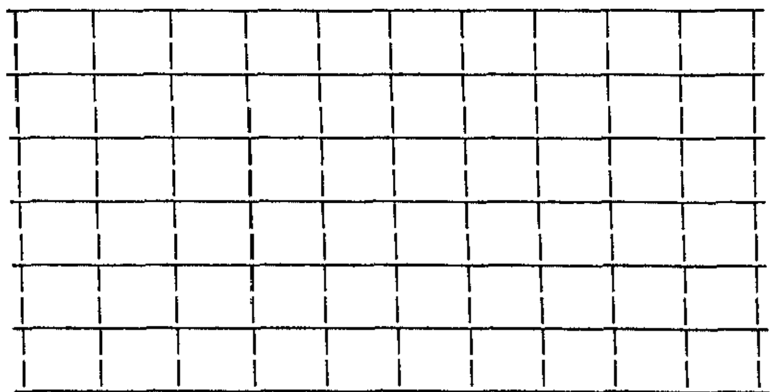
(d) The MRB and peak power are always transmitted at the same time.

d. With the "O"scope probe still at J1-3 (RDM), set the bearing dial to read 180°, record the waveform in the space below and answer the questions.

(1) The peak of the observed signal, in relationship to the MRB, is LEADING/LAGGING/IN PHASE by ________ degrees.

(2) The simulated aircraft's position is magnetic ________ of the station.

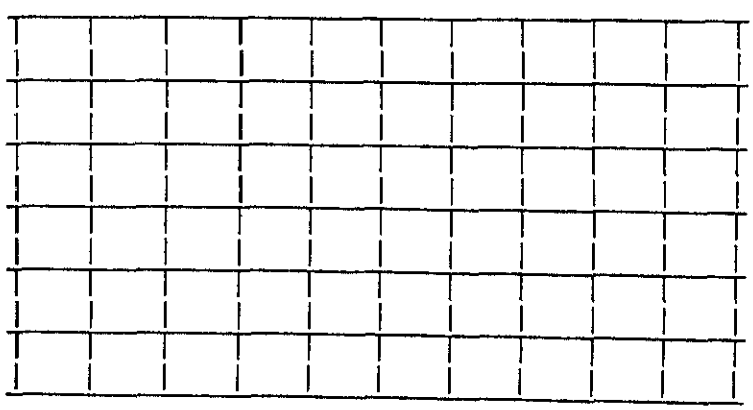
e. With the "O"scope probe at J1-3 (RDM), set the bearing dial to read 090°, record the waveform in the space below and answer the questions.



(1) The peak of the observed signal, in relationship to the MRB, is LEADING/LAGGING/IN PHASE BY ________ degrees.

(2) The simulated aircraft's position is magnetic ________ of the station.

f. With the "O"scope probe at J1-3 (RDM), set the bearing dial to read 000°, record the waveform in the space below and answer the questions.



(1) The peak of the observed signal, in relationship to the MRB, is LEADING/LAGGING/IN PHASE by ___________ degrees.

(2) The simulated aircraft's position is magnetic ___________ of the station.

g. Return BEARING DIAL to 270 degrees.

4. Composite waveform analysis

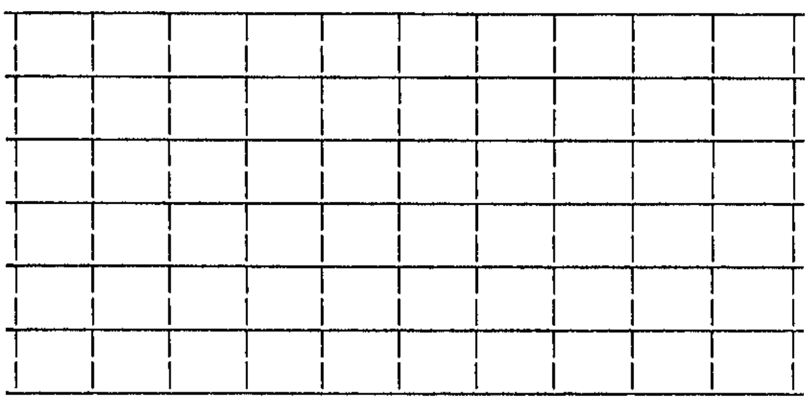
a. Main Reference Burst

(1) Observe J1-3 (RDM) with the probe.

(2) Set the oscilloscope TIME/DIV control to the 50 usec position.

NOTE: The MRB should be present; if not, recheck your work.

(3) Record the waveform in the space provided below.



b. Auxiliary Reference Burst

(1) Observe J1-3 (RDM) with the probe.

(2) Set the TIME/DIV control to the 5 msec position.

(3) Pull out the black (outer) section of the TIME/DIV control and turn it to the 20 usec position. (Ensure the clear section remains at the 5 msec position.)

(4) Set the HORIZ DISPLAY switch to the A INTEN DURING B position.

(5) Reduce the INTENSITY slightly until a bright spot is visible on the display.

(6) Rotate the DELAY TIME MULTIPLIER until the bright s
is positioned over the ARB desired.

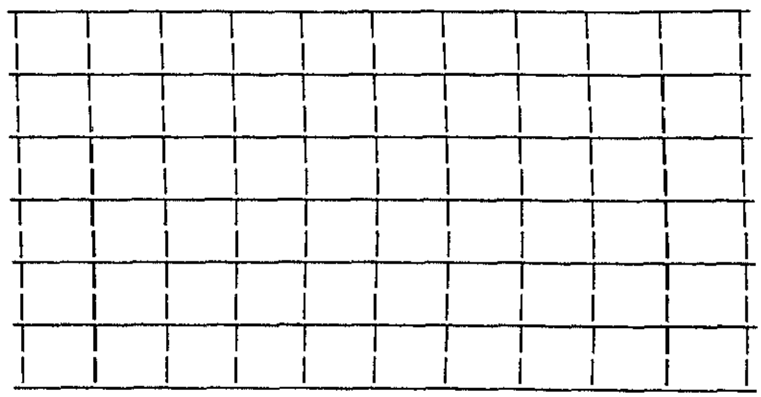
(7) Set the HORIZ DISPLAY switch to the DELAYED SWEEP (
position.

(8) Increase the INTENSITY slightly.

(9) Fine adjustment of the DELAY TIME MULTIPLIER may be
necessary to center the ARB.

NOTE: AN ARB should be present. If not, recheck your work and then consult an instructor if necessary.

(10) Record the waveform in the space provided below.



5. This completes the laboratory assignment.

a. Secure laboratory position using STANDBY or SECURE procedures in Information Sheet 9.2.1I.

b. Turn in workbook for grading.

c. Ask questions about confusing material.

INFORMATION SHEET 9.4.1I

TACAN BLOCK DIAGRAM ANALYSIS

INTRODUCTION

To successfully complete the TACAN Block Diagram Analysis lesson, you must have a basic overview of all circuit modules used in the TACAN trainer. This information sheet is provided so you can accomplish this task.

REFERENCE

Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

INFORMATION

1. RF Module (1A1A14)

   a. Purpose
      (1) Select the proper crystal and generate an RF signal as a carrier for transmission and as a local oscillator frequency for conversion.
      (2) Convert, amplify, and detect the received video.
      (3) Modulate the RF for transmission of an interrogation pulse pair.
      (4) Amplify the RF to a usable level for transmission.

   b. Components of the RF module
      (1) Channel servo circuits
      (2) Frequency multiplier
      (3) Transmitter-preselector
      (4) IF amplifier
      (5) Modulator

2. Range Decoder Module (1A1A1)

   a. Decodes the detected video from the RF module.
   b. Detects amplitude of signal for AGC voltage.
   c. Detects the ID tone for application to a headset.
   d. Separates the range and bearing signals.
   e. Supplies a ringing tone to control the antenna selector module in RCVR, and T/R modes of operation.
   f. Supplies a 4045.7 Hz signal to the range A module and the range mechanical module.

3. Range A Module (1A1A2)

   a. Develops the interrogation trigger at 120 to 150 Hz or 22 to 30 Hz.
   b. Develops early and late coincidence pulses for application to the range B module.

4. Range B Module (1A1A3)

   a. Converts early and late coincidence pulses to magnetic amplifier control voltages.
   b. Supplies countdown ground in track to range A module to switch PRF to 22 to 30 Hz.
   c. Controls the search/track modes of operation.
   d. Develops the 10 second memory for the range circuits.

5. Magnetic Amplifier Module (1A1A11)

   a. Supplies drive voltage to range mechanical module.
   b. Supplies drive voltage to bearing mechanical module.

6. Range Mechanical Module (1A1A12)

   a. Supplies synchro information to the range indicator.
   b. Supplies a positive d-c potential varying between approximately +2 volts and +7 volts to the range A module for coarse range information.
   c. Supplies a phase-shifted 4045.7 Hz signal to the range A module for fine range information.

7. Bearing Decoder Module (1A1A4)

   a. Detects the amplitude modulation from the composite waveform.
   b. Supplies a 15 Hz reference square wave to the bearing module.
   c. Supplies a 135 Hz reference square wave and a 15 Hz ringir burst to the bearing B module.

8. Bearing A Module (1A1A5)

   a. Supplies unprocessed 15 Hz modulation to the bearing decoder module.
   b. Supplies bearing magnetic amplifier control voltages.

9. Bearing B Module (1A1A6)

   a. Supplies 40° coincidence signal to the bearing A module.
   b. Supplies 135 Hz unprocessed modulation to the Bearing A module.
   c. Supplies 135 Hz reference to the bearing mechanical module.
   d. Supplies phase-shifted 15 Hz modulation to the bearing A module.

10. Bearing Mechanical Module (1A1A13)

a. Supplies synchro information to the bearing indicator.
b. Supplies phase-shifted 135 Hz signal to the bearing A module.
c. Supplies phase-shifted 15 Hz signal to the bearing B module.
d. Supplies tach feedback to the bearing B module.

11. Air-to-Air Module 1A1A7)

a. Accepts A/A interrogations.
b. Supplies undelayed A/A trigger to the RF module to suppress interrogations until after A/A operation.
c. Develops delay of 49 μsec during A/A operation.
d. Supplies A/A reply trigger to RF module.
e. Develops overall system delay of 62 μsec.

12. Antenna Selector Module (1A1A8)

a. Detects signal from range decoder module or air-to-air module.
b. Selects antenna receiving usable signal.
c. When no usable signal is received, will switch antennas every 4 seconds.

ASSIGNMENT SHEET 9.4.1A

TACAN BLOCK DIAGRAM ANALYSIS

INTRODUCTION

The purpose of this assignment is to familiarize you with the relationship of the modules and major circuits that are used to provide range and bearing information to the pilot. This relationship is one of the most important aids to a technician in the maintenance and repair of any electronic equipment. It would be to your advantage to review this lesson after each of the lessons in this unit to maintain this overview of the circuits.

LESSON TOPIC LEARNING OBJECTIVES

13.1.13. Given the following modules and a list of TACAN information provided to the pilot, MATCH each module with its correct information:

a) RF module
b) Range Decoder
c) Range A
d) Range B
e) Magnetic Amplifier
f) Range Mechanical
g) Bearing Decoder
h) Bearing A
i) Bearing B
j) Bearing Mechanical
k) Air-to-Air
l) Antenna Selector

13.1.14. SELECT, from a given list, the statement that describes the operation of the range system based on the block diagram.

13.1.15. SELECT, from a given list, the statement that describes the operation of the bearing system based on the block diagram.

STUDY ASSIGNMENT

1. Complete Assignment Sheet 9.4.1A.

2. Review notes on the Block Diagrams.

3. Read and review Information Sheet 9.4.1I.

STUDY QUESTIONS

1. The Antenna Selector Module performs what function/s?

   a. Allows the use of one antenna for receive and transmit.
   b. Selects the proper antenna for receive and transmit.
   c. Allows the use of two antennas for air-to-air operation.
   d. Selects the antenna with the first usable signal strength.

2. One of the purposes of the 4045.7 Hz oscillator in the RDM is to

   a. provide fine range accuracy.
   b. provide coarse range accuracy.
   c. provide fine azimuth accuracy.
   d. provide coarse range and azimuth accuracy.

3. The purpose of the countdown MVB is to

   a. establish the random PRF.
   b. control the correct PRF.
   c. generate a pulse at 22-30 Hz in search.
   d. generate a pulse at 120-150 Hz in track.

4. The d-c voltage from the distance measuring potentiometer in the RMM is controlled by

   a. speed of rotation.
   b. direction of rotation.
   c. the indicated range.
   d. the range from the beacon station in search.

5. The gate length of the early gate former and the late gate former is

   a. 12 μs early gate, 12 μs late gate.
   b. 24 μs early gate, 24 μs late gate.
   c. 24 μs early gate, 12 μs late gate.
   d. 12 μs early gate, 24 μs late gate.

6. The memory of the range circuits is how long? ________________

7. What portion of the negative limited video signal does the range circuits use? ________________________

8. The burst eliminator in the BDM performs what function?

   a. Eliminates the MRB and ARB's.
   b. Eliminates the North Burst.
   c. Ensures that the North Burst and the ARB's are not removed from the video before detection.
   d. Controls the peak detector only when the MRB and ARB's occur.

9. The 15 Hz filter and phase adjust

   a. filters out the 15 Hz.
   b. filters the 135 Hz signal out, maintains a constant amplitude signal out.
   c. filters out the 15 Hz and supplies an unprocessed signal to the 5% level detector and an unprocessed signal to the 15 Hz filter and phase inverter.
   d. filters out the 135 Hz and supplies an unprocessed signal to the 5% level detector and an unprocessed signal to the 15 Hz filter and phase inverter.

10. The 40° coincidence circuit output will

   a. enable the bearing circuits to switch from 15 Hz track to 135 Hz track.
   b. enable the search control to switch the feedback from degenerative to regenerative.
   c. have a negative 13 volt output in track.
   d. have a positive 13 volt output in search.

11. What is the purpose of the 5% level detector and what function does it perform?

12. The 135 Hz phase comparator output is applied to the magnetic amplifier drivers when

    ____

13. The 15 Hz filter and the 135 Hz filter accomplish what function?

   a. Change a sine wave to a square wave
   b. Change a square wave to a sine wave
   c. Invert and amplify
   d. Provide a phase-shifted sine wave

14. In 15 Hz track the indicator is

   a. within a 40° sector at $\pm 2/9$ of a degree.
   b. rotating maximum CCW.
   c. within a 15° sector.
   d. within, or at, the correct 40° sector.

INFORMATION SHEET 9.5.1I

RANGE DECODER MODULE - 1A1A1

INTRODUCTION

The Range Decoder Module in the TACAN unit is the module that will determine if the received signal is actually a true TACAN signal. If the signal is true, the RDM will separate it and the signal will be used for bearing and range information in other modules. This information sheet is provided to aid in understanding the circuits that accomplish these functions within this module.

REFERENCE

<u>TACAN Systems Maintenance Trainer, Device 8H7 Maintenance Handbook with Parts List</u> for NAVTRADEV P-3577

INFORMATION

The Range Decoder Module is composed of the following major circuits: Decoder, Amplifier and Limiter, AGC, ID Tone, and a 4.0457 kHz Oscillator. The purposes of this module are to decode the detected video from the RFM, separate the range and bearing signals, develop an AGC voltage to control the gain of the IF amplifiers in the RFM, produce an identification tone used to identify the ground station and usable antenna signal strength, and to generate a 4.0457 kHz reference signal for range timing and varying the transmitter PRF.

<u>Decoder</u>

This section will be used to decode the detected video to ensure the other modules and sections are using only TACAN signals. The detected video output from the RFM is applied to the decoder circuits in the RDM. The input signal is coupled through C1 to emitter followers Q1 and Q2. The output of Q1 is applied through matching resistor R3 to a 12 microsecond delay circuit, DL1. This output is negatively clipped by CR1 and applied to the base of emitter follower Q3. The detected video applied to Q2 is negatively clipped by CR2 and applied to a one-half attentuator. An attenuation of one-half is obtained by resistors R7 and R10, so that the amplitude of emitter follower Q4's output is approximately the same as the output of emitter follower Q3. Both outputs of Q3 and Q4 are converted through the ANALOG AND Gate composed of CR3 and CR4. An output is present at emitter follower Q5 only if the pulses from Q3 and Q4 are 12 microseconds apart. The output of Q5 is a single pulse for each standard TACAN pulse pair received by the unit. MRB's will appear as 12 pulses, 30 microseconds apart, and ARB's will appear as 11 pulses, 12 microseconds apart. Due to CR3 and CR4 being configured as an analog circuit, the amplitude

modulation will be maintained across the decoder circuits. This output is applied to amplifier AR1, which provides a single pulse output that coincides with the second pulse of the two pulse input.

Amplifier and Limiter

This section is used to separate the range and bearing signals for use in the other modules to obtain the information desired. The output of AR1 is applied to emitter follower Q10, as amplitude modulated video, for use in the Bearing Decoder and the Air-to-Air modules. The output of AR1 is also applied through deenergized relay K1, to comparator AR2, to remove the amplitude modulation so that only pulse presence or absence is evident. AR2's negative reference is established at pin 5 by the voltage divider R27 and potentiometer R28. The negative limited video output of AR2 is applied through delay network components R29, R30, and C6, to grounded comparator AR3. The output AR3 will be a delayed negative limited video signal applied to the bearing decoder module.

ID Tone

The ID Tone circuits will detect the tone for application to the Control Panel for use in a headset and to the ASM to control antenna selection in the REC and T/R modes of operation. The negative limited video from AR2 is also applied to the ID tone circuits composed of a bandpass filter, emitter follower, and a push-pull amplifier. The bandpass filter components include resistors R33 thru R36, capacitors C7, C8, and active bandpass filter AR4. The bandpass filter is tuned to 1350 Hz, which is present only when the ID Tone is transmitted by the ground station. When no ID Tone is being generated by the ground station, the filter will react slightly to MRB's, ARB's, and squitter pulses that are occurring at a subharmonic rate of the 1350 Hz center frequency. Potentiometer R36 provides an adjustment for the center frequency of the filter. The ID Tone is applied through emitter follower Q6 to the ASM, where the tone will control antenna selection. The output of AR4 is also applied to a transistor push-pull amplifier, designed to drive a 6 ohm headset. Amplifier transistors Q7 and Q8 are connected to matching transformer T1. The output taken across R3 is a 1350 Hz ID ringing tone signal applied to the control panel for monitoring through the headset.

AGC

The AGC section will detect the amplitude of the received signal for conversion to a d-c voltage level which is used in the RFM as automatic gain for the IF amplifiers. The decoded output of emitter follower Q5 is also applied to AGC component AR5. Part of the Q5 output is developed across R42 and R41 and is fed to comparator AR5. The reference level at pin 4 is adjustable by potentiometer R45. The output of AR5 switches when the input level at pin 5 exceeds the reference level. The output is then fed to

clamper circuit components R46, C9, CR5, and CR6. When AR5's output is negative, capacitor C9 discharges through CR6 to a filter on pin 5 of AR6. The pulse amplitude is converted to a d-c level through this circuit. The filter is composed of C10, C11, R49, and R47, and limited in its charge level by several components. CR11 and R60 are used to speed up the response time of the AGC circuit by bypassing R49 when the voltage on C10 is more negative than that on C11. Potentiometer R63 serves as an adjustment for the most positive excursion (low limit) of the AGC voltage on C11 through CR13. CR12 limits the most negative excursion (high limit) of the AGC voltage. The charge on the filter is applied to voltage follower, AR6, which reproduces the voltage on pin 5, however, the voltage now has a much lower source impedance. The output (-2 V d-c to -6 V d-c) is applied to the control grids of the IF amplifier tubes in the RFM.

4.0457 kHz Oscillator

The 4.0457 kHz crystal-controlled oscillator circuit is composed of AR7, crystal Y1, active bandpass filter AR8, and emitter follower Q9. It will supply a 4.0457 kHz signal to the RAM and RMM. This signal is used as the basic timing reference of the range circuits and affects the range measurement accuracy. AR7 and Y1 make up a crystal-controlled, free-running oscillator. The output at AR7, pin 10, is fed back to both the noninverting input, pin 5, and inverting input, pin 4. In this configuration negative feedback is obtained for all frequencies where the crystal impedance is very large, except at the crystal frequency. Feedback to the non-inverting input is greater than the feedback to the inverting input, changing the feedback from negative to positive, so that a 4.0457 kHz oscillation is obtained. The square wave output is applied to an active bandpass filter composed of AR8, resistors R55, R56, R57, and capacitors C14 and C15. This bandpass filter is identical in operation to the ID Tone bandpass filter described previously. Potentiometer R57 provides a center frequency adjust for the circuit. The sine wave output at pin 10 is applied to emitter follower, Q9, to meet power requirements of the range circuits. It will be used in the RAM to aid in varying the PRF of the transmitter and in the RMM for phase shifting, to obtain fine range accuracy.

Air-to-Air Mode

In the air-to-air mode of operation, two airplanes are working in conjunction with each other to provide range information. Neither airplane has the capability to generate an amplitude modulated waveform and only a reply pulse is required for range information. Therefore, the only signals being received by the unit in this mode are a normal interrogation trigger pulse pair, and an A/A reply pulse. Changes must be made to the different sections of the RDM in order for it to process these signals.

In the A/A mode of operation, a ground applied from the AAM energizes relays K1 and K2 on the RDM. When energized, K1 contacts 1-6 allow the detected video input to bypass the decoder circuit and to be applied directly to comparator AR2. The bypass allows the system to respond to single replys used in the A/A mode. This switching does not affect the decoding circuits related to the amplitude modulated video. Relay K1 also switches the reference level of AR2 from a negative to a positive level, generated by resistor R25 and potentiometer R26 (the threshold adjust). In the A/A mode, K2 contacts 6-1 connects C23 to ground. Having this capacitor connected from AR3 output to ground will short the output of AR3. This will cause the bearing system to search when in the air-to-air mode of operation.

Relay K2 affects the RC time constant of the clamper circuit in the AGC section, and allows the circuit to react to single pulses, rather than the composite waveform. Since there are less pulses in the A/A mode, relay K2 inserts resistor R48 in series with R47 to increase the RC time constant of the clamper circuit. Capacitors C22 and diodes CR8 and CR9 act the same as C9, CR5, and CR6 did in the REC and T/R modes. However, in the REC and T/R modes, relay K2 grounds the output of this circuit through R59. When in the A/A mode, the output of R59 is applied to the junction of R47 and R49 and will directly charge C10 through CR10. Relay K2 also applies a ground, through contacts 5-2, to the base of Q6 and R37. This prevents the ID Tone circuits from responding, by grounding the limited video signal.

ASSIGNMENT SHEET 9.5.1A

"RANGE DECODER MODULE ANALYSIS"

INTRODUCTION

The purpose of this assignment is to familiarize you with the operation and functions of the RDM within the TACAN unit. Once this is understood, the signal flow to the other modules will be easier to understand.

LESSON TOPIC LEARNING OBJECTIVES

13.1.16. From a given list, SELECT the statement which correctly describes the overall operation of the Decoder section.

13.1.17. From a given list, SELECT the statement which correctly describes the overall operation of the Amplifier and Limiter section.

13.1.18. From a given list, SELECT the statement which correctly describes the overall operation of the ID Tone section.

13.1.19. From a given list, SELECT the statement which correctly describes the overall operation of the AGC section.

13.1.20. From a given list, SELECT the statement which correctly describes the overall operation of the 4.0457 kHz Oscillator section.

13.1.21. From a given list, SELECT the statement which correctly describes the overall operation of the RDM in the Air-to-Air mode of operation.

STUDY ASSIGNMENT

1. Review notes on Block and Schematic Diagrams.

2. Read Information Sheet 9.5.1I.

3. Complete Assignment Sheet 9.5.1A.

STUDY QUESTIONS

1. After decoding, the MRB will appear as

   a. 12 pulse pairs spaced 30 μseconds apart.
   b. 11 pulses spaced 24 μseconds apart.
   c. 12 pulses spaced 24 μseconds apart.
   d. 12 pulses spaced 30 μseconds apart.

2. After decoding the ARB will appear as

a. 12 pulses spaced 24 μseconds apart.
b. 12 pulses spaced 12 μseconds apart.
c. 11 pulses spaced 12 μseconds apart.
d. 11 pulses spcaed 24 μseconds apart.

3. In the Amplifier and Limiter section of the decoder R29, R30 and C6 provide what function?

a. A 12 μsecond delay
b. A 2 μsecond delay
c. A 11 μsecond delay
d. A phase shift of 90°

4. Why is the reference voltage of AR2 changed to a positive reference ?

a. In normal operation the static output of AR1 is -13 V d- and it is removed from AR2 in A/A.
b. In normal operation the static output of AR1 is a +13 V and it is removed from AR2 in A/A.
c. In A/A operation the output of AR2 is a static -13 V d-c
d. In A/A operation the input signal is referenced to zero volts.

5. At J1-13, with no ID Tone being received, a small amount of ringing is present. Why?

a. The MRB and ARB's are subharmonics of 1350 Hz.
b. R36 is misadjusted.
c. Abnormal operation.
d. Relay K2 is energized.

6. AR6 performs what function?

a. Inverter
b. Comparator
c. Voltage Follower
d. Operational Amplifier

7. The voltages on pin 5 of AR6 are limited by what components?

a. R63, CR12 and CR13
b. R62, R63, and CR12
c. R61, R63, R60, CR12 and CR13
d. R61, R62, R63, CR12 and CR13

8. The amplitude modulated video line to the AAM contains what information in A/A operation?

   a. None
   b. Bearing information
   c. A/A replies
   d. Range interrogations

JOB SHEET 9.6.1J

RANGE DECODER MODULE ANALYSIS

INTRODUCTION:

This job sheet will provide you with guidance while performing the Range Decoder Module lab. This lab will aid you in understanding the Range Decoder Module operation.

ENABLING OBJECTIVE:

13.3.5 With the aid of an oscilloscope, OBSERVE waveforms at specified test points on the Range Decoder module and RECORD them in the student workbook.

13.3.6 With the aid of an oscilloscope, TAKE voltage readings at specified test points and RECORD them in the student workbook.

13.3.7 ANALYZE a composite waveform, taken at a specified test point, by RECORDING its component parts in the student workbook and labeling each part with its correct name.

13.3.8 With the aid of an oscilloscope, TAKE a waveform at a specified test point, RECORD it in the student workbook and LABEL it as being either TONE or SQUITTER pulses, based on whether they are random or synchronized pulses.

REFERENCE: Maintenance Handbook with Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

EQUIPMENT AND MATERIALS:

1. Job Sheet 9.6.1J
2. Information Sheet 9.2.1I
3. AN/ARM-22A Radio Test Set
4. Type 453 Oscilloscope with 10:1 probe
5. 8H7 TACAN Training Device
6. Straight Slot Screwdriver

PRECAUTIONS TO BE OBSERVED:

1. 1800 V d-c in RF Module
2. When extending a module, the metal lock tabs must remain down at all times.
3. Remove only the four small coax cables on the simulator, Nothing Else.
4. No test point readings may be taken on the backside of the module.
5. Plastic cover over the power supply must always remain down.
6. Do not check or remove any fuses.

7. Standby and Secure procedures are listed on Information Shee 9.2.1I.
8. Do not place TACAN mode switch in T/R until the TACAN power supply has timed out (90 seconds).
9. No jewelry will be worn in the lab.

PROCEDURE:

CAUTION: CARE MUST BE EXERCISED WHILE WORKING ON ENERGIZED CIRCUITS.

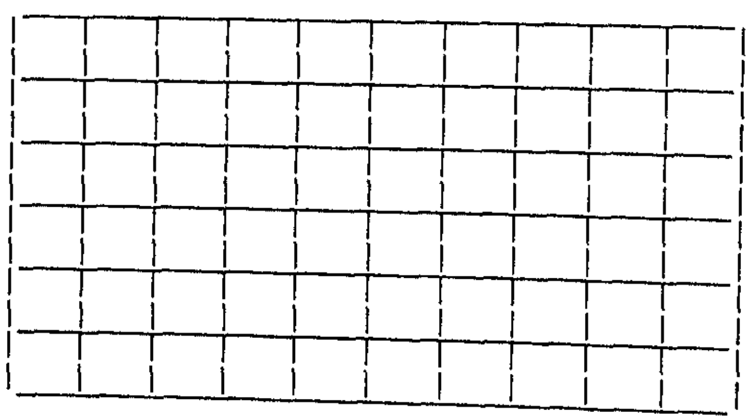
1. Preliminary Setup

   a. Ensure that the equipment is turned off when removing and replacing modules to utilize the extender board.
   b. Utilize ranging system block, functional block, and schematics of the RANGE DECODER as necessary to complete this assignment.
   c. Set up the TACAN trainer and associated test equipment and perform an operational check. (Refer to Information Sheet 9.2.1I)
   d. Observe waveforms as described in the following steps. When required, record waveforms and answer the questions in the spaces PROVIDED on this job sheet.

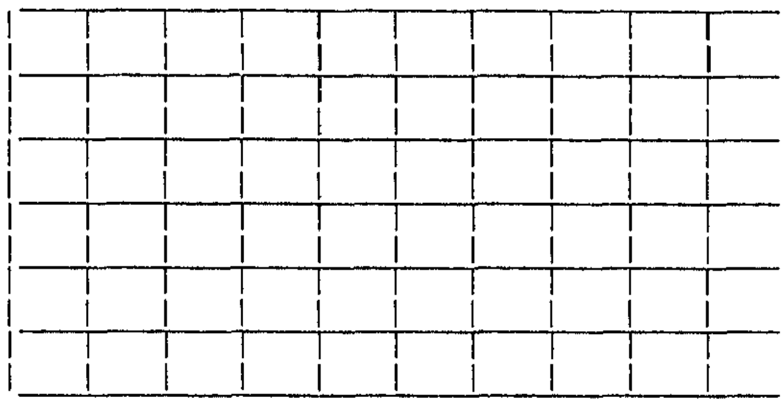
2. Circuit Analysis

NOTE: ALL WAVEFORMS WILL BE TAKEN WITH THE OSCILLOSCOPE SET FOR ONE CYCLE OF THE TACAN COMPOSITE WAVEFORM, UNLESS OTHERWISI NOTED.

   a. Decoder circuits.
      (1) Observe and record the following in the spaces provided below.
         (a) Input to Decoder at J1-3.



(b) Output from Q5 at J1-5.



(2) Adjust the Time/Division to observe the MRB at J1-3 and J1-5; then answer the question listed below. Return to composite waveforms time setting (50 msec).

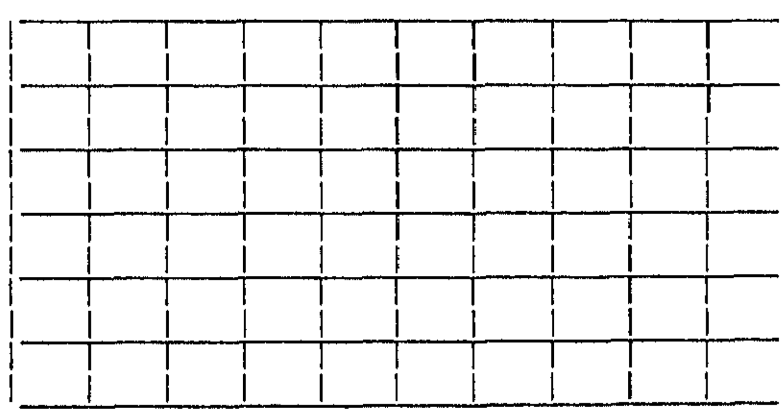
(3) Name the circuits which caused the difference in the MRB between the two signals observed. ______________

____

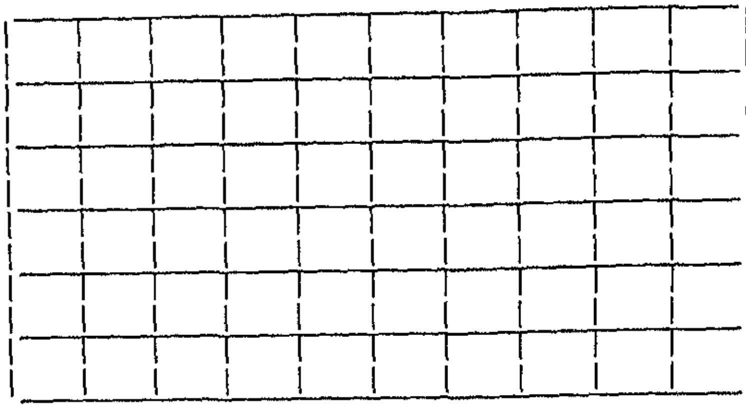
b. Amplifier and Limiter circuits

(1) Observe and record the waveforms in the spaces provided below.

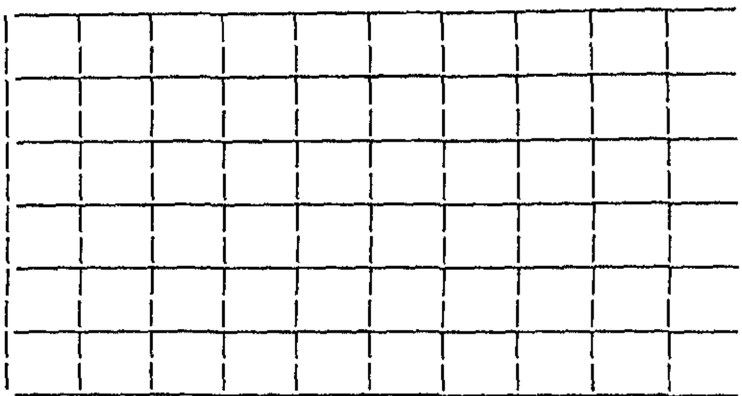
(a) Output from Q10 at J1-11.



(b) Output from AR2 at J1-12.



(c) Output from AR3 at J1-10.



c. The question below pertains to the three signals taken above.

(2) List where these signals are applied and what they are used for.

J1-11 ______________________________

J1-12 ______________________________

J1-10 ______________________________

d. AGC circuits

(1) Observe and record the results in the spaces provided below.

(a) AR6 output with optimum signal in (-50dBm) at J1-14.

______________________ V d-c

(b) AR6 output with no signal in (CW OUT) at J1-14.

______________________ V d-c

NOTE: Return Function Selection Switch back to pulse out.

(c) AR 6 output with maximum signal in (0 dBm) at J1-14.

______________________ V d-c

(2) Explain the relationship of the input signal at J1-5 and the output signal observed at J1-14 of the AGC after taking the above voltage readings.

____

____

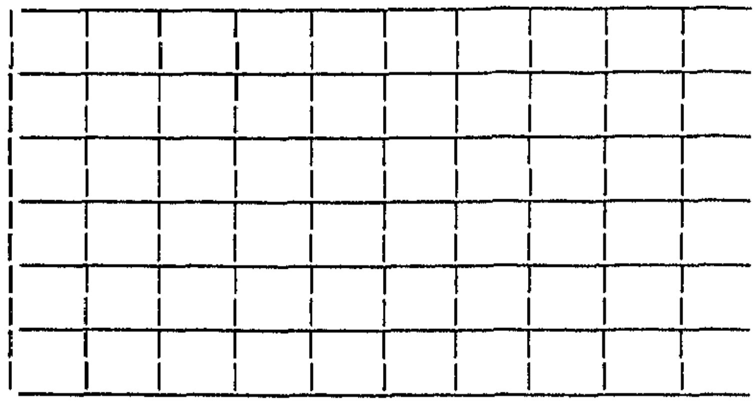
e. ID tone circuits.

NOTE: Place the pulse output selector on the pulse generator in the tone position. Set oscilloscope Time/Division switch to display only the MRB and the first ARB at J1-3 in the first nine divisions of the "O"scope.

(1) Observe and record the waveforms in the spaces provided below.

(a) AR4 input at J1-12.

(b) J1-8.



(2) Place pulse output selector on the pulse generator back to squitter range position. Observe the difference in the waveform. Answer the below question.

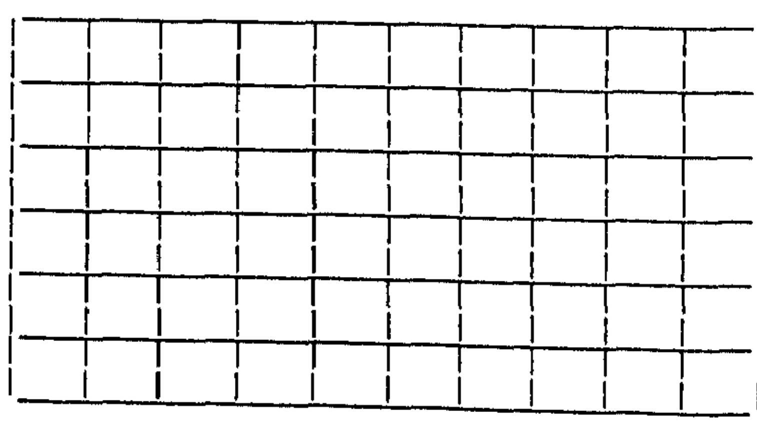
What happened to the squitters when you turned the pulse output selector switch to the tone position, then back to squitter range position.

f. 4.0457 kHz circuits

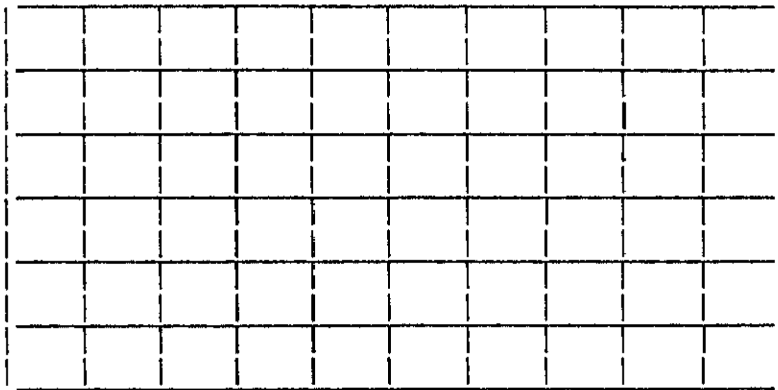
NOTE: PLACE THE OSCILLOSCOPE "A" TRIGGERING SOURCE TO INTERNAL and adjust the Time/Division knob to observe one cycle of the waveform.

(1) Observe and record the waveforms in the spaces provided below.

(a) AR7 output at J1-15.



(b) Q9 output at J1-16.



(2) Answer the below questions.

(a) What caused the difference between the two waveforms observed at J1-15 and J1-16?

____

____

(b) What is the purpose of the signal observed at the output of Q9? ______________________________

____

3. This completes the laboratory assignment.

a. Secure laboratory position using STANDBY or SECURE procedures in Information Sheet 9.2.1I.

b. Turn in workbook for grading.

c. Ask questions about confusing material.

INFORMATION SHEET 9.7.1I

AIR TO AIR MODULE ANALYSIS

INTRODUCTION

The Air-to-Air (A/A) Module in the 8H7 TACAN trainer is used to replace the range functions of the Ground Station (G/S) when two aircraft are working in conjunction in situations such as in flight refueling operations. This information sheet is designed to aid in understanding the circuits which accomplish the functions in this module.

REFERENCE

TACAN System Maintenance Trainer, Device 8H7 Maintenance Handbook with Parts List for NAVTRADEV P-3577.

INFORMATION

The airborne unit has no capability to generate a composite waveform, so any information needed between aircraft must be provided by the use of either single pulses or pulse pairs. In order for the system to give the pilot range information, two signals are required to be generated. They are an Interrogation pulse pair and an A/A Reply that serves the same function as the Range Reply that was generated by the G/S. This A/A reply will be used by the airborne unit to produce the needed range information for the pilot. (see figure 1)

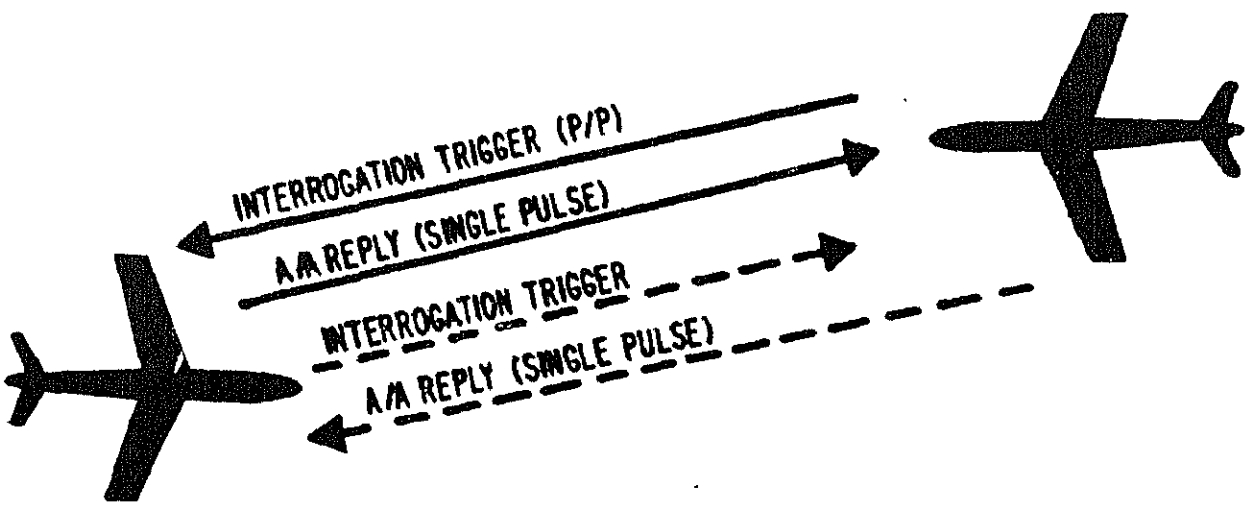


Figure 1 Air-to-Air Transmissions

The Air-to-Air module will be used to generate the needed repl) accomplish the following functions:

1. Develop an overall system delay of 62 µsec. for the range circuits in the A/A mode of operation.
2. Supply an undelayed A/A trigger to the RFM to suppress interrogations until after A/A transmission is complete.
3. Supply an A/A Reply trigger to the RFM.
4. Supply a Blanking signal to the RAM to prevent transmissi during mode changes.
5. Supply an A/A Latching signal to the ASM for antenna selection in the A/A mode of operation.

Air-to-Air Interrogation pulses from Q10 in the Range Decoder M (1A1A1) are applied to the negative input of the Air-to-Air Threshold Amplifier AR1. A negative reference level is establi by potentiometer R3, and resistor R4 is applied to the positive input of AR1. Amplifier power is connected through contacts of relay K4, which is energized by the ground through the 2-4 cont of deenergized relay K3 in the Air-to-Air Mode only. When the input level becomes more positive than the reference level, AR1 10 will switch from a positive to a negative level. The transition, which lasts as long as the Interrogation pulse thre level is held, is differentiated by capacitor C1 and resistor R and is applied to Q1 of the Air-to-Air Transponder Delay One-Sh Multivibrator. R10 provides an adjustable pulse width that is for an overall system delay of 62 microseconds. The incoming signal is coupled through C2 to the base of Q2 causing the MVB produce a 49 microsecond positive gate to C4. The positive gat coupled through C4 to overcome the adjustable level at CR1 (set R12, R13 and R14 to ground through switch Q3). It is then appl to the Air-to-Air Reply Trigger Generator components CR1, C5 an CR2 turning Q4 ON. The positive level at Q4 emitter (establish by resistors R17 and R18) provides a positive pulse lasting 2-4 microseconds. This reply trigger is applied to the RFM for transmission 62 microseconds after an interrogation pulse is received. (see figure 2)

Figure 2 Module Delays in A/A Operation

The ground provided through switch Q3 for level adjustment at potentiometer R13 is controlled by two input signals. When in T/R or RCVR modes of operation, a ground from the Control Panel (1A2) is provided to energize relay K3 to remove a ground from relays K4 and K5, keeping them deenergized. In this condition two circuits are affected. Power is removed from Air-to-Air Threshold Amplifier AR1 so that no A/A reply trigger will be generated. Also, in Blanking Circuit Relay K5, +15 volts connected through the 6-8 contacts charges capacitor C7 through Q5, R21 and CR5. Transistor Q5 is OFF at this time, with +15 V d-c on its collector, reverse biasing diode CR7 and allowing Q3 to be ON. When a mode change from T/R to A/A is initiated, relay K3 will deenergize, connecting ground to relays K4 and K5 and to the RDM and RFM. Relays K4 and K5 energize connecting Zero Distance Potentiometer R29 to the RAM, power to AR1 and switching the +15 V d-c from the 6-8 contacts to the 6-1 contacts of relay K5. Capacitor C8 will charge through Q5, R21 and CR6 and C7 discharges through diode CR4. Q5 will turn ON for approximately two seconds. This negative blanking gate is applied to the RAM to stop interrogation triggers from being transmitted by the RFM, thereby allowing the circuits to settle down during mode changes. Another mode change from A/A to T/R causes the same blanking operation at the RAM.

The negative gate out of Q5 also turns Q3 OFF to disable the Air-to-Air Reply Trigger Generator. In its OFF state the ground is removed from level circuit resistors R12, R13, and R14, reverse biasing diode CR1 to prevent reply trigger generation. A second Q3 control is provided by the Transmitter Muting input from the RFM. When the system is using one channel, this input is at ground potential. However, if a channel change is made, the input becomes a negative gate that forward biases diode CR8 to turn Q3 OFF.

Relay switching performed in the Air-to-Air Module is as follows: In the T/R or A/A mode, +28 V d-c is applied to transmitter relay K2 and to receiver relay K1 through the contacts of K3. Relay K2 connects +26 volts 400 Hz to the Range Mechanical Module motor and tachometer and 50 volts 400 Hz transmitter power to the RFM.

Relay K1 connects +28 V d-c to the Antenna Selector Module and 115 volts 400 Hz to the bearing and range magnetic amplifiers. If a mode change from T/R or A/A to REC is initiated, relay K1 will be energized by +28 V d-c in the module. During receive mode of operation, transmitter power is not required and since range information is not used in this mode, power to the motor and tachometer is removed.

ASSIGNMENT SHEET 9.7.1A

AIR TO AIR MODULE ANALYSIS

INTRODUCTION

The purpose of this assignment is to familiarize you with the operation and functions of the AAM within the 8H7 TACAN trainer. Once this is understood, the signal flow to the other modules will be easier to understand.

LESSON TOPIC LEARNING OBJECTIVES

13.1.22. SELECT, from a given list, the statement which describes the operation of the Air-to-Air Transponder Delay One-shot Multivibrator.

13.1.23. SELECT, from a given list, the statement which describes the operation of the Reply Pulse Generator.

13.1.24. SELECT, from a given list, the statement which describes the operation of the Blanking Control.

STUDY ASSIGNMENT

1. Complete Assignment Sheet 9.7.1A.

2. Read Information Sheet 9.7.1I.

3. Review notes on Block and Schematic Diagrams.

STUDY QUESTIONS

1. Q4 will be triggered ________ μsec after an input appears at AR1 by the ___________ edge of the __________ gate out of Q2.

2. When will CR7 be forward biased? ________________________________

3. When will CR8 be forward biased? ________________________________

4. Briefly explain the operation of the circuitry controlling Q5.

   ____

   ____

5. When Q3 is OFF, CR1 will be _________ and Q4 will ______________ ____________.

6. During the A/A mode of operation, which of the following conditions are present?
   a. K2, K3, K4 and K5 are all energized.
   b. K2, K4 and K5 are energized, K3 is deenergized.
   c. K4 and K5 energized, K2 and K3 are deenergized.
   d. K2 deenergized, K3, K4, and K5 energized.

7. List the outputs of the AAM, where they go and their purposes.

____

____

____

____

8. What is the purpose of R13? ______________________

9. Describe the signal present at J1-16 in the A/A mode of operation. ______________________

INFORMATION SHEET 9.8.1I

RF MODULE - 1A1A14

INTRODUCTION

The RF Module in the 8H7 Training Device is the same as the one found in the AN/ARN-52 TACAN Navigation Set. It contains the receiver and transmitter sections that are needed to convert and detect the received signal as well as generating an RF signal for modulation and amplification. This information sheet is provided to aid in understanding the circuits which accomplish the functions in this module.

REFERENCES

TACAN Maintenance Trainer, Device 8H7 Maintenance Handbook with Parts List for NAVTRADEV P-3577.

Maintenance Instructions, TACAN Navigation Sets, AN/ARN-52(V), AN/ARN-86(V) and AN/ARN-105, NAVAIR 16-30 ARN 52-9.

INFORMATION

The purposes of the RFM are as follows:

1. Select the proper crystal and generate an RF signal as a carrier frequency for transmission and as a local oscillator frequency for conversion.
2. Convert, amplify, and detect the received video.
3. Modulate the RF for transmission of an interrogation pulse or an A/A reply.
4. Amplify the RF a usable signal for transmission.

Channel Servo Circuits

The channel servo circuits are activated by an error signal from the Control Box when a channel change is initiated. This signal will unbalance a bridge network which will cause the Turret Servo Motor to turn. While the motor is turning, the Frequency

tripler. The crystal turret contains the 126 crystals needed generate the transmit frequency between 1025 and 1150 MHz. Cr selection is determined by the position of the turret servo mo V1401 is an oscillator/doubler dual triode tube. The "A" side the tube is a Modified Butler Oscillator which is mechanically tuned to the third harmonic of the crystal frequency (see figu 1). V1401B doubles the output of V1401A to give an output frequency that is 6 times the crystal frequency. This frequen

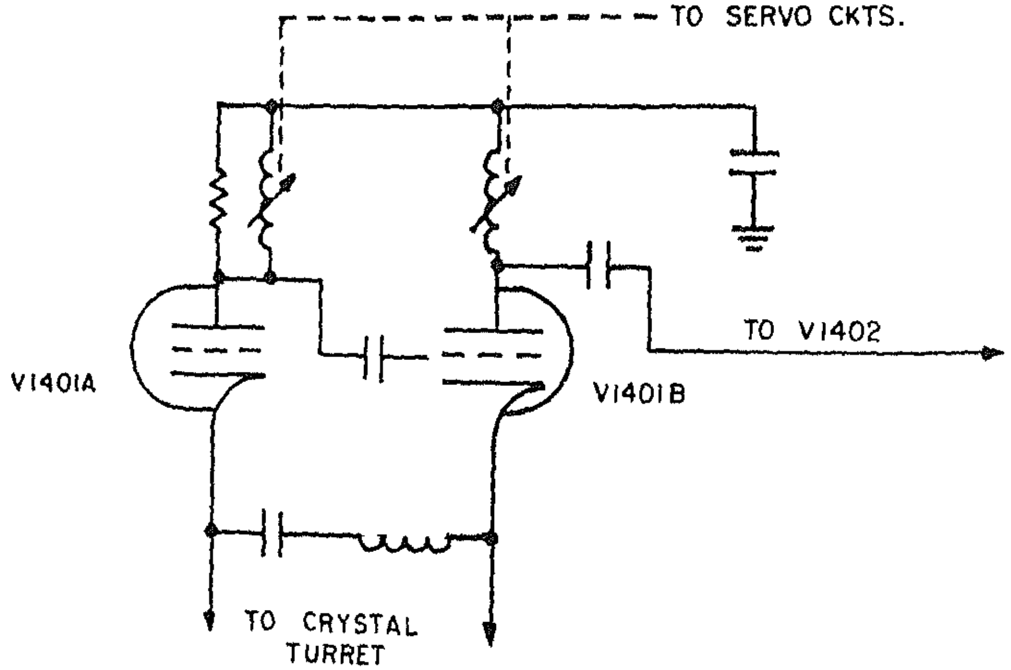


Figure 1

further multiplied by V1402, V1404, and V1405 to the desired RF Carrier Frequency. The crystal frequency has been multiplied 72 times and is applied to the RF Amplifier tubes in the Preselector as the carrier frequency for transmission. It is also applied to CR1202, where it will be used as the local oscillator frequency f the receive function. Each stage of the Frequency Multipliers is mechanically tuned by the servo motor and the final output is disabled by the Muting Relay until after the channel change is complete.

Transmitter Preselectors

The Transmitter Preselectors consists of the RF Amplifiers, two Preselectors, and a Crystal Mixer.

The RF Amplifiers (V1201-V1204) will pulse modulate and amplify th carrier to the desired output level for transmission. Each tube i a cascade type amplifier that is coaxially connected to the next stage. 1800 V d-c from the High Voltage supply Z1501, is applied to the tube plates in T/R and A/A modes only. The tubes are

statically held CUT OFF by a +68 V d-c level on their cathodes. Modulation is accomplished by impressing a large negative pulse to the cathodes by the modulator.

The received RF signal is fed from the antenna through the antenna switch to the Preselector cavities. The preselector assemblies are divided into two pairs of tuned cavities, one pair for the HIGH BAND (1151-1213 MHz) and a second pair of cavities for the LOW BAND 962-1024 MHz). Electrically the cavities function as extremely hi Q tuned circuits, thus passing only a very narrow band of frequencies about the desired frequency. Series connection of the two cavities of each band further increases selectivity of the pre-selectors. RF energy is coupled into the first cavity by a coupling loop and from the first to the second cavity by a window-like aperture. The tuned frequency of the cavities is varied by tuning rods, which are driven by the channel servo motor. The two cavities not in use are shorted to ground by mechanical fingers which project through slots in the cavity walls. The receiver frequency bands are reversed in the Air-to-air mode of operation and the two planes must be operating 63 channels apart.

The output signal of the preselector is coupled to Mixer CR1202. The transmitting frequency signal is also coupled to CR1202 from the Frequency Multipliers. The Mixer produces the sum and difference frequencies and because the transmitting and received frequencies on a channel are 63 MHz apart; the IF frequency of 63 MHz is sent to the IF Amplifiers.

IF Amplifiers

V1601, the input stage of the IF Amplifiers, is connected in a modified cascode circuit to form a low noise, high gain amplifier. The plate circuit of V1601 is tuned (as are the plate circuits of all the amplifiers in this section) to the desired IF Frequency. V1602 is a high gain pentode amplifier whose output is fed to V1603. V1603A is a crystal-controlled Pierce Oscillator operating at a constant 54.5 MHz. V1603B is a mixer that has the 63 MHz IF frequency and the oscillator frequency applied to it, and will produce the sum and difference frequencies out. The resultant 8.5 MHz difference will be felt to V1604. Four amplifier stages are used (V1604, V1606, V1609 and V1606) which are cascade connected for high gain. The output of V1606 is fed to diode Detector CR1601 which will detect the video from the IF Frequency for amplification by Video Amplifier V1607. The positive video output signal is then sent to the Range Decoder Module.

To prevent overdriving V1609 and V1606 when strong signals are applied to the unit, which would cause distortion and loss of signal, an alternate path of detection is provided. In this case the signal at the plate of V1605 is detected by CR1604 in the deblocking circuit and then fed to V1607.

Modulator Section

The modulator consists of the pulse generting, shaping, switching, and protective circuits required to produce the T/R pulse pairs and A/A single reply pulses that modulate the RF power amplifiers.

Interrogation trigger pulses from the RAM are fed to DL1501 through Emitter Follower Q1508. The Delay Line will generate two separate pulses that are 12 μseconds apart. These outputs are delayed by 1 μsecond to allow time for the activation of the suppression circuits which will be discussed later. The first output of the delay line is applied to Pulse Generator CR1513, and 12 μseconds later the second output is applied through Emitter Follower Q1510 to Pulse Generator CR1516. The pulse generators contain PFN's that will convert the input triggers to large negative pulses that are 3.5 μseconds wide at the 1/2 power points. These pulses will be combined into a Standard TACAN Pulse Pair in the Modulation Transfomer T1501 and applied to the cathodes of the RF Power Amplifiers as the modulation signal.

In the Air-to-Air mode, the Air-to-Air reply pulses from the AAM are applied through Emitter Follower Q1503 to the A/A 1 μsecond Delay. The output is also delayed 1 μsecond to allow for the activation of the suppression circuits, and then a single pulse is applied to Pulse Generator CR1510. Operation is similiar to that of the Interrogation Modulation circuits discussed earlier.

The suppressor circuitry produces a positive gate during TACAN transmission to blank or desensitive equipment operating in the same frequency band. CR1519 or CR1520 receives the Interrogation or A/A Reply Pulse as soon as it is generated and triggers Monostable MVB Q1511 and Q1512. The MVB produces a 25 μsecond positive gate that is shaped and amplified by Q1513 and Q1515 to give a sharp trailing edge to the suppression gate. The output is routed to the Blanking Circuit Q1514 and to an external jack to blank other equipment. Blanking circuit Q1514 will cause the AGC circuits, Q1516 and Q1517, to produce a -20 V d-c level to the grids of the IF amplifier tubes, thereby blanking the receiver while transmission is occurring. During normal receiver operation the AGC circuits provide a low impedance source for the IF amplifiers, thereby connecting the AGC output of the RDM to the grids of the tubes.

After the transmitter has been fired, it is necessary to prevent it from being triggered until the pulse forming networks have had sufficient time to regain its charges. Since the Interrogation pulses and the Air-to-Air Reply pulses are random, a 170 μsecond gate is generated immediately after the suppression gate is complete. The trailing edge of the output of the Shaper Amplifier Q1513 and Q1515 will trigger a One-Shot MVB composed of Q1505 and Q1506, producing a 170 μsecond positive gate that is one input to the Inhibitor Circuits, which will be discussed later.

In the Air-to-Air mode, a counter circuit counts the Air-to-Air Reply pulses and triggers the Inhibitor circuits when the pulse rate exceeds a preset level. This limits the maximum duty cycle of the transmitter to a safe level. The random input pulses are applied to Storage Counter Q1521 through Emitter Follower Q1503. If the pulse repetition rate exceeds 750 pulses per second the counter will trigger One-Shot Multivibrator. CR1547, Q1509, and Q1522 will provide a 20 millisecond positive gate to the Inhibitor circuits when triggered by Q1521.

The Inhibitor circuit is used to inhibit the inputs to the Modulator so that the transmitter will not be fired. Inputs to the Inhibitor circuits are:

1. Transmitter Protective circuits
2. Air-to-Air Storage circuits
3. Muting - a +20 V d-c level when a channel change is initiated
4. Initial Inhibiting - a 33 millisecond positive gate as soon as B+ is applied to the tubes to allow for warmup and stabilization

When Emitter Follower Q1523 is triggered by any of the four input signals it will turn ON both Q1501 and Q1507. Then these transistors are ON, they become a very LOW impedance and inhibit or shunt the triggers to Q1508 and Q1503. This action prevents the triggers from firing the transmitter.

When the TACAN set is operating in the Air-to-Air mode with several cooperating aircraft, the Air-to-Air reply pulses become more important than the interrogation pulses. To insure priority of the reply pulses, and to protect the transmitter against a simultaneous transmission of an Air-to-Air pulse and a normal interrogation pulse, Q1502 and Q1504 is triggered 48-50 μseconds before the Air-to-Air Reply pulse is generated by the Undelayed A/A Pulse from the AAM. The A/A Priority circuit will generate a 170 μsecond positive gate that will turn ON Inhibitor Q1507, thereby preventing the Interrogation pulses from the RAM from firing the transmitter.

ASSIGNMENT 9.8.1A

RF MODULE ANALYSIS

INTRODUCTION

The purpose of this assignment is to familiarize you with the operation and functions of the RF Module within the TACAN unit. Once this is understood the signal flow to the other modules will be easier to understand.

LESSON TOPIC LEARNING OBJECTIVES

13.1.25. Given the circuits below and a list of purposes, MATCH each circuit with its correct purpose

a) Channel Servo Circuits
b) Frequency Multipliers
c) Transmitter Preselectors
d) IF Amplifiers
e) Modulator

13.1.26. Given the circuits below and a list of statements, MATCH each of the circuits with the statement which describes its operation

a) Pulse Pair Generator
b) A/A Reply Pulse Generator
c) Suppression Circuits
d) AGC Circuits
e) A/A Storage Circuits
f) Transmitter Protective Circuits
g) A/A Priority Circuits

STUDY ASSIGNMENT

1. Complete Assignment Sheet 9.8.1A.
2. Read Information Sheet 9.8.1I.
3. Review notes on Block Diagram.

STUDY QUESTIONS

1. List the sections of the RFM that are mechanically tuned.

____

2. When is 1800 V d-c applied to the RF Amplifiers?

____

3. When will the Frequency Multipliers be disabled?

4. For what reason is double conversion used in the IF's?

5. Explain the use of the Deblocking circuit.

6. For what purpose is DL-1501 used in the Modulator?

7. The pulse width out of the Modulator is determined by what type circuit?

8. What is the purpose of the 1 μsec. delays in the Modulator?

9. What determines when the A/A Storage Counter will be triggered?

10. Name the four inputs to Q-1523 and where they come from.

11. What is the purpose of the Initial Inhibiting input?

12. On the trailing edge of the 25 μsec. suppression gate a 170 μsec. gate is developed. What is this gate used for and where is it applied?

13. Explain how the receiver is blanked when transmitting.

14. Explain why the A/A Priority circuit is used.

INFORMATION SHEET 9.9.1I

ANTENNA SELECTOR MODULE ANALYSIS

INTRODUCTION

The Antenna Selector Module provides automatic switching between two antennas that are located on the aircraft's fuselage. It will also select the antenna that is receiving the first usable signal. This information sheet is provided to aid you in understanding the circuits within the Antenna Selector Module, which accomplish these functions.

REFERENCE

TACAN Systems Maintenance Trainer, Device 8H7 Maintenance Handbook with Parts List for NAVTRADEV P-3577.

INFORMATION

The Antenna Selector Module provides automatic switching between two antennas when neither an ID ringing tone (in Rx or T/R mode) or Air-to-Air Latching pulse (in A/A mode) are present at the inputs of the ASM (Search condition). The ASM also provides the proper antenna selection when the input signal is at a usable level (Track condition).

During the Search condition, with AR3 pin 10 at +13 V d-c, diode CR8 is reverse biased and transistor switch Q3 is ON. The +13 V d-c, diode out of AR3 was established by the negative reference level on pin 4 set by R13 and R14. In this condition the searching interval astable multivibrator, composed of Q4, Q5 and associated components, is switching at approximately 2 second intervals. The multivibrator's switching rate is adjusted by potentiometer R34. Each output pulse at Q5's collector is a +5 V d-c to 0 V d-c transistion applied to pulse steering network capacitors C7 and C8. At the same time, a d-c level, established by the ground connection through switch Q3, allows both diodes CR9 and CR10 to be alternately forward and reverse biased, by the 5 volt to 0 volt input transition. The switching action causes transistors Q1 and Q2 of the selected memory bistable multivibrator to be alternately ON and OFF, at approximately 4 second intervals. This action turns Q6 ON and OFF, transistors Q6, Q7 and Q8 all simultaneously turn ON and OFF to control the externally located antenna switch, causing the two antennas to switch at 4 second intervals between 0 and 28 V d-c.

In the Track condition, the 1350 Hz I.D. ringing tone sine wave, in the REC or T/R modes of operation, is rectified by diode CR4, low pass filtered and applied to comparator AR2's inverting input. A positive reference level for AR2 is established by resistor R11 and potentiometer R10. When the input signal amplitude is sufficiently positive to charge capacitor C5 above the reference level at AR2 pin 5, the output at pin 10 will switch to -13 V d-c. This output is applied to CR5, one input of a two input OR gate. The second input to this module is the A/A Latching signal which is coupled through capacitor C1 and clipped positively by diode CR1. Each negative pulse will forward bias CR2 allowing filter capacitors C2 and C3 to charge negative. When the voltage level at AR1 pin 5 exceeds the negative reference level at pin 4, established by R5 and potentiometer R4, AR1 pin 10 switches to -13 V d-c to forward bias CR3, the second input to the OR gate. When the OR gate is forward biased, the output allows capacitor C6 to rapidly charge negative through diode CR6. As C6 charges, the same potential is felt on comparator AR3 pin 5.

If the level on pin 5 becomes greater (more negative) than the reference level on pin 4, established by R13 and R14, AR3 pin 10 output will switch to -13 V d-c, initiating a change form the Search to Track condition. When AR1 output goes to -13 V d-c, diode CR8 becomes forward biased, turning Q4 OFF. This causes no further switching to occur. Switch Q3 is turned OFF to remove the multivibrator ground so both diodes, CR9 and CR10, are reverse biased by the positive cathode potential through R24. The multivibrator will remain in the last state that existed (Q1 or Q2 on). Due to the reverse bias condition of CR9 and CR10 no further switching will occur and the antenna switch will now be connected to only one antenna. If the input signal to the Antenna Selector Module is lost, memory capacitor C6 will discharge through R12. The RC discharge time is approximately 10 seconds. After this memory time the d-c level at AR3 pin 5 becomes positive enough for the switching sequence of the Search Condition to be initiated.

ASSIGNMENT SHEET 9.9.1A

ANTENNA SELECTOR MODULE ANALYSIS

INTRODUCTION

The purpose of this assignment is to familiarize you with the operation and functions of the ASM within the TACAN unit. Once this is understood the signal flow to the other modules will be easier to understand.

LESSON TOPIC LEARNING OBJECTIVES:

13.1.27. SELECT, from a given list of inputs, the inputs that control the Antenna Selector Module.

13.1.28. SELECT, from a given list of statements, the statement that describes the operation of the Antenna Selector Module in the Search mode.

13.1.29. SELECT, from a given list of statements, the statement that describes the operation of the Antenna Selector Module in the Track mode.

STUDY ASSIGNMENT

1. Read Information Sheet 9.9.1I.

2. Review notes on Block and Schematic diagrams.

3. Complete Assignment Sheet 9.9.1A.

STUDY QUESTIONS

1. What type of circuits are the input circuits to AR1 and AR2?

   ____

2. The memory capacitor for the ASM is ____________________.

3. When the ASM is in the Search mode of operation, AR3's output is ________ volts.

4. The astable MVB has a switching time of ____________ which is adjustable by ______.

5. The identification signal is transmitted from the ground station every ________________.

6. The memory time of the ASM is ___________________.

7. Why does the ASM not go into the Search mode of operation between identification signals?

____

____

8. Explain how the ASM is switched from Search to Track mode (operation.

____

____

9. In Track mode of operation, what would be seen at J1-14?

____

INFORMATION SHEET 9.10.1I

TACAN POWER SUPPLIES

INTRODUCTION

All electronic equipment in use today needs certain operating voltages for the individual components to work. These voltages are obtained by the use of power supplies which break down the voltages of the aircraft generating plant. This information sheet is provided to aid in the understanding of the circuits which accomplish these functions.

REFERENCES

1. TACAN Systems Maintenance Trainer, Device 8H7 Maintenance Handbook with Parts List for NAVTRADEV P-3577.

2. Maintenance Instructions, TACAN Navigation Sets, AN/ARN-52(V), AN/ARN-86(V), and AN/ARN-105, NAVAIR 16-30 ARN 52-5.

INFORMATION

Power Supply 1A1A9

Power Supply Module 1A1A9 provides regulated ± 15 V d-c and unregulated +28 V d-c for all of device 8H7 circuits. Four power supplies are used to generate all voltages. When Control and Indicator POWER switch is set at ON and the MODE switch is in any other position except OFF, then 115 volts 60 Hz is applied to input transformer 1A1T1 primary located on the receiver-transmitter main chassis. One secondary of the power transformer is connected to bridge rectifier CR1 through CR4. The unregulated +28 V d-c output is filtered by 1A1C1 and applied to the AAM. A second identical 28 V d-c power supply composed of bridge rectifier diodes CR9 through CR12 and capactive filter 1A1C3 provide relay operate power.

Two regulated power supplies generate +15 V d-c and -15 V d-c Bridge diodes CR5 through CR8 rectify 1A1T1 pin 7 and 8 secondary output. The rectified voltage is capacitively filtered (1A1C2 and C7) and applied to current limiter 1A1Q1 collector and to IC Voltage Regulator (U1) input at pin 3. The emitter output is applied through current sensor Q1 as the supply +15 V d-c output. The output is developed across R6 and C3 and fed back to the IC Voltage Regulator on the output sense line (pin 5). Changes in load conditions cause the IC Regulator circuit to control 1A1Q1 base voltage and thereby the voltage drop across 1A1Q1 and the power supply output. A voltage divider circuit (R1, R2 and R3) is

connected to U1, a d-c level shift circuit for adjusting, at poten tiometer R2, the output voltage. Resistors R4 and R5 are biasing components and capacitors C1, C2 and C3 provide filtering.

The -15 V d-c Power Supply is identical to the +15 V d-c Power Supply, except that the reference is switched and current sensing transistor Q2 emitter is at the same potential as current limiter 1A1Q2 emitter. IC U2 provides power supply regulation. Output voltage adjustment is controlled by potentiometer R8.

Power Supply 1A1A15

The 1A1A15 power supply will provide all a-c and two of the d-c voltages necessary for the operation of the 8H7 Training Device. When the Control and Indicator POWER switch is ON and the MODE Switch is in any other position but OFF 115 volts 400 Hz is applie to pin 3 of T801 and through T802 to the primary of T803.

+120 V d-c Supply

Voltage is picked up at the 4-5 secondary winding of T801 and fed to diode bridge rectifier CR803 through CR806. The rectified output is fed through L801 to the collector of Series Regulator Transistor Q801. Due to the action of K802 and Thermal Relay K801 (to be discussed later), Q801 will be CUT OFF for the first 90 seconds after power is applied. The output of Q801 is fed from it emitter to a sensing bridge circuit, R810, R812, R815, R814, poten tiometer R813 and zener diode CR809.

The outputs of the sensing bridge are applied to the bases of Q805 and Q806 which are connected as a differential amplifier. The bas of Q805 is connected to zener diode CR809, maintaining this base a a 9.3 V d-c reference above ground. Since the emitters are common, the input to the base of Q806, from R813, represents the voltage necessary to maintain equal conduction of Q805 and Q806 required i order to get a +120 V d-c output. The output voltage from Q805 collector is fed to d-c amplifiers Q804 and Q803. The amplified

voltage to decrease. This decrease in voltage is felt to the base of Q802 reducing the conduction of Q802 thus delivering less drive to Q801. This allows more of a voltage drop across Q801, due to a decrease in conduction, and tends to decrease the output voltage to +120 V d-c.

-108 V d-c Supply

The 6-7 secondary windings of T801 supplies the energy for the -108 V d-c Regulated Supply. The operation of this circuit is essentially the same as the +120 V d-c Regulated Supply. In the -108 V d-c Regulated Supply, driving transistor Q808 is close to the -108 V d-c level and is connected as an amplifier in cascade with Q809 and Q810. Q808 drives the series regulating transistor, Q807, through isolation diode CR814.

A-C Voltage Supply

Transformer T803 provides 6.3 V a-c for all tube filaments, 6.0 V a-c for the cavities and a delayed 50 V a-c supply for the High Voltage Power Supply (Z1501) in the RFM. The regulation for the a-c voltage supplies is provided by a Magnetic Amplifier Series Regulator, T802, in the input circuit of T803. The secondary windings of T803, besides supplying the necessary a-c voltages, supply a sensing circuit for the Magnetic Amplifier through the 3-4 windings. The a-c output of the 3-4 winding is rectified by the diode bridge rectifier CR819 through CR822. The output of the bridge is filtered by R828 and C811 and applied to the sensing bridge. This bridge consists of R829, R830, R831, and the 5-6 winding of T802 as one side, and R833, and zener diode Cr823 as the other side. Zener diode CR823 is a temperature compensated diode operating at 5.6 volts. The detection portion of the bridge consists of Q813 and Q814.

The positive and negative portions of the a-c voltage are passed through separate windings of T802, such that the ampere-turns are additive. The degree of core saturation is reduced by the ampere-turns of the amplifier operated control windings in the Magnetic Amplifier. The collector current of Q813 flows through control windings 4-5 of T802. This current serves to reduce the degree of saturation of the core, since the ampere turns of winding 4-5 partially cancel those of 1-2 and 1-3. Potentiometer R830 adjusts so that the rated output is supplied at rated input voltages (i.e. 6.3 V a-c at TP806 with 115 V a-c at pin 1 of T803.

An increase in supply voltage at the input of T802 appears as an increase in the bias at the base of Q813 due to an increase in the rectifier output. This change is amplified and causes the collector current, which flows through the Magnetic Amplifier control windings 4-5, to increase. The control windings ampere-turns are in opposition to the gate winding ampere-turn increase. Therefore, with an increase in control winding current, there is a

DECREASE in the current of the Magnetic Amplifier Series Regula and the rms voltage at the input to T803. The a-c output volta is thus returned to its original value.

90 Second Time Delay

The presence of both the -108 V d-c and the 6.3 V a-c are requi to initiate the +120 V d-c Power Supply (see Fig. 1) and apply to the High Voltage Power Supply. Upon application of 115 a-c

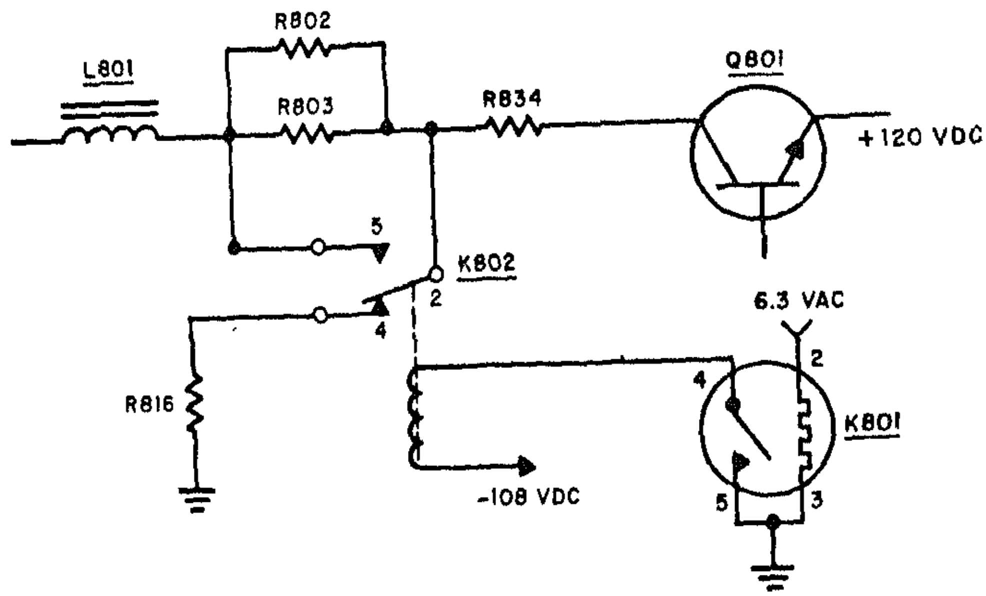


Figure 1

to T802, both Thermal Relay K801 and Interlock Relay K802 are dee gized. Resistors R802, R803, and R816 are connected into the collector circuit of Q801 via contacts 2-4 Relay K802. These resistors reduce the input voltage of Q801 such that it is effectively CUT OFF. Contacts 6-1 of K802 are open, preventing 50 V a from being applied to the RFM. After a specific time delay (approximately 90 seconds) has elapsed since the application of 6. V a-c from T802 across relay K801, this relay operates and completes the ground return path for Relay K802. Since pin 7 of K802 is returned to -108 V d-c this relay is activated by the operation of K801. Energizing Relay K802 removes R802, R803, and R816 from the collector circuit of Q801 thorugh contacts 2-5, whic now make contact. Elimination of these resistors allows the application of the full rectified voltage to be applied to Q801. Contacts 6-1 of Relay K802 also make and 50 V a-c is now applied t Z1501 in the RFM.

This described relay action supplies filament voltage to all the tubes used in the equipment, and, after sufficient warm up has been attained, supplies the full plate voltage to them.

ASSIGNMENT SHEET 9.10.1A

TACAN POWER SUPPLIES

INTRODUCTION

The purpose of this assignment is to familiarize you with the operation of the power supplies within the TACAN unit. The most important, but least understood section of any electronic equipment, is its power supply.

LESSON TOPIC LEARNING OBJECTIVES

13.1.30. Given the 1A1A9 and the 1A1A15 power supplies and a list of purposes, MATCH each of the power supplies with its purpose.

13.1.31. SELECT, from a given list, the a-c and d-c outputs from the 1A1A9 and the 1A1A15 Power Supplies.

13.1.32. Given the circuits below and a list of statements, MATCH each of the circuits with the statement which describes its operation.

a) +120 V d-c supply and regulator
b) -108 V d-c supply and regulator
c) 90 second delay circuit
d) +28 V d-c circuits
e) +15 V d-c supply and regulator
f) -15 V d-c supply and regulator

STUDY ASSIGNMENT

Complete Assignment Sheet 9.10.1A.
Read Information Sheet 9.10.1I.
Review notes on Schematic Diagrams.

STUDY QUESTIONS

1. What is the purpose of the +28 V d-c power supplies?

____

2. What is the purpose of CR807? ______________________

____

3. R803 has no current flow when ______________________________

4. CR808 is used for what purpose? ______________________________

5. Q814 and CR823 provide ______________________________

6. Briefly explain how T802 and associated circuits compensate for a change in input voltage. ______________________________

____

____

____

7. 60 seconds after power is applied, __________V d-c will be present at TP803 and 30 seconds later, ______ V d-c will be present.

8. What would cause an increase in conduction of Q810? __________

____

9. Q803, Q804, Q805 and Q806 are configured as what type of circuits? ______________________________

10. C807 and C810 provide __________ as well as C802 and C806.

11. Briefly explain how an increase in voltage is compensated for at TP803.

____

____

____

INFORMATION SHEET 9.11.1I

RANGE A MODULE - 1A1A2

INTRODUCTION

Systems that measure range between two given points must generate a pulse and then need to be able to measure the time it takes for that pulse to go to a given point and return. The Range A Module is the module in the TACAN that contains the circuits used to measure this time relationship. This information sheet is provided to aid in the understanding of the circuits which accomplish these functions within this module.

REFERENCE

TACAN Systems Maintenance Trainer, Device 8H7 Maintenance Handbook with Parts List for NAVTRADEV P-3577.

INFORMATION

The Range A Module generates early and late coincidence pulses required by the Range B Module to drive the range magnetic amplifier and interrogation triggers for transmitting by the RFM.

Countdown Multivibrator

A 4.0457 kHz sine wave from the RDM is applied to pulse former AR1, which will give an output square wave of the same PRF. The square wave is differentiated by capacitor C4 and resistor R12 and the resultant signal is applied to one side of Astable Timing Oscillator AR2. The pulses are summed at AR2 pin 5 with a 115v 400 Hz jitter signal and feedback from AR2 pin 10 through R11. The base frequency of the oscillator is established by capacitor C3 and resistor R13, R14 and potentiometer R15.

A second input affecting AR2 is the Countdown Ground from the RBM. When the system is in the search condition, the ground is not present and AR2's repetition rate is random between 120 and 150 Hz. When the system is in the track condition, a countdown ground from the RBM connects capacitors C1 and C2 in parallel with C3, changing AR2's repetition rate to 22 to 30 Hz. The Astable Timing Oscillator's output is applied to one side of Inverter AR3. When AR3 is operating normally, the input is inverted at the output; however, either of two inputs can shut off AR3 to prevent any output. A transmitter muting signal from the RFM (generated when switching between channels) or a negative blanking signal from the AAM (generated when switching between T/R and A/A modes) will turn OFF Switch Q1. In its OFF state the ground to AR3 is removed and approximately +4 V d-c, established by R19 and R20, is applied to AR3, preventing it from passing the signal.

The output of AR3 is applied to two circuits. Capacitor C7 and resistors R23 and R24 differentiate the square wave and the negative transition will turn Switch Q2 ON. The positive on its emitter is felt on the collector and applied to the RFM as a range interrogation trigger for transmitting. This signal will set time-zero for the range timing circuits. This signal can be viewed at J1-2, and will be a 50v positive pulse, 2-4 microseconds wide.

Coarse Range Gate Circuits

The second output of AR3 is to the coarse range gate circuits composed of flip-flop U2, inverter AR4, switch Q3, integrator AR5 and comparator AR6, all connected in a closed loop configuration to initiate the search for the Range Reply.

The square wave from AR3 is differentiated by R21, R22, and C6 and the negative portion will drive NAND gate U2B pin 5 LOW (0 V d-c) from its +5 V d-c level (HIGH) through R22. A negative on pin 5 drives the output at pin 6 positive (Hl) regardless of the voltage on the other gate input at pin 4. Inverter AR4 switches to -13 V d-c, forward biasing diode CR4 and turning J-FET switch Q3 OFF with a negative on its gate. Capacitor C12, which was bypassed by Q3 while it was ON, will now charge and Sweep Integrator AR5, whose output was at 0 V d-c, will now be a positive going sawtooth that is applied to the negative input of comparator AR6.

The reference level of AR6 is a slowly increasing positive d-c voltage from the distance measuring potentiometer. This level is determined by resistors R65, R66, R67 and the potentiometer wiper position. Potentiometer R65 is connected to the bottom of the range potentiometer and establishes the starting voltage. Resistor R66 and potentiometer R67, connected to the top of the range potentiometer, establishes the maximum wiper output. As the range potentiometer is motor driven through one revolution the wiper picks off a voltage/distance level (2 to 7 volts representing 0 to 300 miles).

When the ramp output of AR5 (occurring at 120 to 150 Hz in the search mode) reaches the much more slowly increasing reference level, AR6 output will switch form +13 V d-c to a -13 V d-c level that is applied to U2A pin 1 input. The output at U2A pin 3 will now be a HIGH fed to U2B pin 4. During no pulse time (AR3 quiescent) U2B pin 5 is at a positive level set by resistor R22 and the two positive (HIGH) inputs cause NAND U2B output pin 6 to go LOW, driving AR4 output to a +13 V d-c, in turn reverse biasing CR4 to turn Q3 ON. Capacitor C12 is now bypassed and AR5 output goes

occurring at 120 to 150 Hz (in search) are capacitively coupled through C16 to monostable multivibrator AR7 initiating the search for the range reply. At this initiation of a search for the range reply the negative going pulse from AR6 switches AR7 to a positive level lasting 190 μsec. This gate, called the Coarse Range Gate, is fed to one input of Selector NAND Gate U2C pin 9.

Fine Range Pulse Circuits

The second input to U2C, at pin 10, is a fine range pulse which will be representative of a 20 mile rotation of the range indicator. Inputs to this circuit are the 4.0457 kHz resolver outputs that have been phase shifted 360 degrees everytime the range indicator moves 20 miles. They are applied to amplifier AR8 which applies it to a shifting network.

When an interrogation pulse is transmitted to a ground station, a 50 μsec delay is provided by that station prior to generating an interrogation reply (Range Reply). This delay, used to obtain range information, is compensated for at the output of AR8 by phase shift components R59 and C20. In T/R mode the phase shift is adjustable by potentiometer R61, which is connected through P1-C to ground in the Air-to-Air module. In A/A mode P1-C is open and P1-B is connected to ground through A/A mode Zero Distance Potentiometer 1A1A7R29 for phase shift control. The phase shifted sine wave is applied to comparator AR9 which is referenced to ground. The output is differentiated through C22, R63 and R64 and clipped negative by CR6 and fed to U2C at pin 10. This is the fine range input to the Selector NAND Gate.

Distance Reply Coincidence Circuits

During coincidence with the 190 μsec gate and the pulse form AR9, U2C pin 8 goes negative and triggers monostable multivibrators AR10 and AR11 simultaneously. Multivibrator AR10 generates a positive pulse of approximately 24 microseconds, identified as the late pulse. Multivibrator AR11 generates a positive pulse of approximately 12 microseconds, identified as the early pulse. The late gate is applied to NAND U1D pin 13 and the early gate is applied to NAND U1A pin 1 and to both inputs of Inverter U2D.

The second input to both U1A and U1D NAND gates is derived from the RDM Negative Limited Video output signal. This input, containing range pulses in addition to non-usable information, is coupled through capacitor C9, positively clipped by diode CR7, and fed to monostable multivibrator AR12. Occurrence of a negative pulse triggers the multivibrator which generates a positive pulse of approximately 12 microseconds. During coincidence of a range reply pulse and an early gate, U1A provides a negative pulse that is inverted by U1B and applied to the Range B Module as the early coincidence pulse. Similarly, coincidence of a reply pulse and late gate generates a negative pulse out of U1D, which is inverted

by U1C and fed to the Range B Module as the late coincidence pulse. Gate U2D, which is the early gate inverted, disables the output of U1C, through the use of a Wired AND Gate, to prevent the late coincidence during the occurrence of an early coincidence gate. The resultant outputs are positive pulses of varying pulse widths.

ASSIGNMENT SHEET 9.11.1A

RANGE A MODULE ANALYSIS

INTRODUCTION

The purpose of this assignment sheet is to familiarize you with the operation and functions of the Range A Module within the TACAN unit. Once this is understood, the signal flow to the other modules used to obtain range information will be easier to understand.

LESSON TOPIC LEARNING OBJECTIVES

13.1.33. SELECT, from a given list, the outputs of the Range A Module, their purpose and where they are applied.

13.1.34. From a given list of statements, MATCH the following circuits with the statement which correctly describes their operation:
- a) Countdown Multivibrator.
- b) Coarse Range Gate Circuits.
- c) Fine Range Pulse Circuits.
- d) Distance Reply Coincidence Circuits.

STUDY ASSIGNMENT

1. Complete Assignment Sheet 9.11.1A.

2. Read Information 9.11.1I.

3. Review notes on Block and Schematic Diagrams.

STUDY QUESTIONS

1. On AR2 pin 5, what signals would be observed and what is their purpose?____________________

____

____

2. C1 and C2 are connected in parallel with C3 in the __________ condition.

3. The junction of R6 and R12 functions as a ________________

________________.

4. Q1 is statically _______ and will be _______ when a muting or blanking pulse is received.

5. AR3 functions as a ______________________________.

6. U2B pin 6 is statically

   a. +13 volts.
   b. -13 volts.
   c. -5 volts.
   d. 0 volts.

7. AR4 functions as a ________________ and controls the _____ _______ circuits.

8. Explain why the output of AR6 is only a negative spike?

____

____

____

9. The output of the 190 μsec Single-Shot MVB is the _________ range.

10. When U2C pin 9 goes _________ and pin 10 goes ___________ tl output of U2C will be a negative spike whose width is the sa as the ____________________________.

11. The input to AR8 will be phase shifted 18° for every _______ mile/s of indicator rotation.

12. The junction of U1C pin 8 and U2D pin 11 form a ___________ and its purpose is to ________________________________ ______________.

13. The signals seen at J1-15 and J1-16 are ___________ volts i amplitude.

14. Give the following information for the signal seen at J1-2:

    Amplitude ________________ PW ____________________

    Frequency (search) _____________ (track) ______________

    Purpose ____

INFORMATION SHEET 9.12.1I

RANGE B MODULE - 1A1A3

INTRODUCTION

The Range B Module will convert the time/distance measurement of the Range A Module into mechanical drive voltages for control of the Magnetic Amplifier Module, which controls the Range Indicator. It will also control the Search/Track modes of operation of the range circuits. This information sheet is provided to aid in the understanding of the circuits, which accomplish these functions within this module.

REFERENCE

TACAN Systems Maintenance Trainer, Device 8H7 Maintenance Handbook with Parts List, NAVTRADEV P-3577.

INFORMATION

The Range B Module converts the early and late coincidence pulse outputs of the Range A Module into range magnetic amplifier drive signals and controls search-track-memory mode circuits.

Late and early pulses are applied to transistor switches Q1 and Q2 through capacitors C1 and C2. In the Track Mode, relay K1 (the operation of which will be described later) is deenergized. Late gate pulses turn Q1 ON and apply a negative gate through relay K1 contacts to the base of emitter follower Q3 and through capacitor C4 to the base of Q6. The negative gate on Q3 turns it ON, thereby forward biasing diode CR1 and charging capacitor C5 in a negative direction. At the same time, early gate pulses turn Q2 ON, driving its collector negative. This negative pulse passes through relay K1 contacts and capacitor C3 to turn Q5 OFF. The collector of Q5 goes positive, turning Q7 ON to forward bias diode CR2 and charge capacitor C5 in a positive direction. The purpose of charging C5 in both the positive and negative directions is to generate a magnetic amplifier drive voltage.

If either the early or late gate pulse is wider than the other, capacitive direction of charge will be either positive or negative. Identical circuits charge capacitor C6 positively through Q6, Q8 and CR3 or negatively thorugh Q4 and CR4. When coincidence are equal, C5 and C6 charges are identical. If the late gate is wider than the early gate, C5 charge will be less positive and C6 charge will be more positive. Both d-c levels are applied to non-inverting operational amplifiers (AR1 and AR2) having a gain of two. The outputs of AR1 and AR2 are level shifted by a positive voltage through R41 and R42 to keep magnetic amplifier drivers Q9

and Q10 in their operating ranges. Also connected to Q9 and Q10 base input is a tachometer feedback signal from the Range Mechanical Module through relay K5. This relay is energized only when the system passes from Search into Track which occurs at the acquisition of late gates. In search no feedback is present. When energized, K5 connects the feedback signal to inverting amplifier AR3 which has a variable gain. The output at pin 10 is fed to the base of Q9 and to the negative inverter AR4. AR4's output is applied to the base of Q10.

At the emitter of Q9, relay K5 (deenergized in search) causes approximately 5 volts d-c to be present, keeping Q9 OFF at all times. The ground at K5 connected through resistor R100 puts the collector of Q10 near ground, which is the same as turning it ON. Capacitors C9 and C10 provide magnetic amplifier tuning. This causes the magnetic amplifier to be unbalanced, driving the motor at full speed in the direction of increasing range (0 to 300 mi). The emitter circuit of Q10 contains balance potentiometer R48, which provides an 80-120 ohm load. When relay K5 is energized, the 100 ohm emitter load can be matched by altering R48.

Early and late gate pulses are also applied to one-shot multivibrators. The early gate multivibrator, composed of Q12, Q14 and associated components, has its output taken off Q14 collector, which is normally at +15 volts with Q14 turned ON. The late gate multivibrator, composed of Q11, Q13 and associated components, has its output taken off Q13 collector, which is also at +15 volts. Each late gate pulse drives Q13 OFF, putting a negative on Q15 bas to turn it ON, forward biasing diode CR16, and charging C17 negatively. This negative charge is passed to C19 which establishes the input level on AR5 pin 5. When enough late gate pulses are present to charge C19 more negative than the reference input (established by R79 and potentiometer R77), AR5 output will switc negatively. Diode CR18 will be forward biased and the negative d level will turn Switch Q17 OFF. In this condition, ground is removed from parallel connected K1, K3 and K4 relay coils, which will deenergize to indicate that enough pulses are present to switch out of search.

The input to Q17 base is from a three input diode OR Gate, one of which is CR18. The second input is controlled by relay K6. When relay K4 is deenergized by the acquisition of late pulses, parall relays K5 and K6 energize through the now closed contacts of K4. The charge on C24 returns to ground through R90, driving AR8 pin negative below the reference level at pin 4. Comparator AR8 outp will switch to approximately -13 volts d-c forward biasing diode CR22 of the OR Gate to turn Q17 OFF for the length of "late track memory time" (approximately 200 milliseconds).

The third input to control Q17 is from AR7. While in track relay K2 (to be described later) is deenergized, and capacitor C23 is charged. Should either early or late track pulses be lost, relay

K2 will energize to initiate a memory time that is dependant upon the length of time the system was in track. When energized, K2 connects ground to R87 to provide a discharge path for C23 initiating memory before switching back to search. While in memory AR7 output is negative, keeping Q17 OFF and relays K1, K2 and K4 deenergized to disconnect the coincidence inputs. It should be noted that a memory disable line is also connected to the input of AR7. If a range was being displayed and the channel at the control panel is switched, the RFM connects a ground through diode CR9 to immediately discharge C23, thus disabling the memory.

As described previously, relay K2 is energized in Search and deenergized in Track. Both early and late pulses control the operation of this relay through a diode AND Gate. Each late pulse turns Q14 OFF forward biasing diode CR15. Each late pulse turns Q13 OFF, forward biasing diode CR14. With both multivibrators triggered, Q16 base will be negative, turning it ON. The negative emitter voltage forward biases diode CR17 to charge C18 and C20, which establishes the input level to AR6. Comparator AR6 operates in the same manner as AR5 and has an adjustable reference level at R80. When the negative input is greater than the threshold level, AR6 output will switch to approximately -13 volts d-c. This negative level reverse biases Q18 base to turn it OFF deenergizing relay K2.

Other relay switching in the Range B Module is as follows:
When deenergized relay K4 connects a ground to the Range A Module countdown multivibrator to change its repetition rate from 120-150 Hz (Search) to 22-30 Hz (Track). Relay K4 in its deenergized state also connects ground to relays K5 and K6, which will energize. Relay K5 connects ground to 100 ohms at Q10 collector described previously. Relay K6 disconnects a ground from the input resistors of AR5 and AR6 to slow down the discharge rate of the input capacitors. Deenergized relay K2 (in Track only) connects a ground to the range indicator flag which will pull back to allow range display. When energized ground is removed from the flag allowing it to block the range indication. When relay K3 is energized (deenergized in track) its contacts connect resistors R103 and R105 across C5 and C6 to hold the voltage on those capacitors to zero.

<u>MAGNETIC AMPLIFIER MODULE</u> - 1A1A11 (Refer to overall range block taught in lesson 9.4)

Both the range and the bearing magnetic amplifiers are located on this module and work approximately the same. The magnetic amplifier module provides the drive voltages necessary in the Range and Bearing Mechanical Modules. The range magnetic amplifier consists of two saturable transformers with the outputs wired in series opposition. Each core has an additional control winding arranged so that no a-c coupling exists between it and the other windings. The primary and secondary windings of each core are closely coupled with no current in the control winding. When current is passed through the control winding, the core tends to

saturate and the coupling of the transformer is reduced. In Search operation, terminal 14 of the range magnetic amplifier is connected to ground and terminal 12 is opened by the magnetic amplifier driver on the RBM. Thus, no current flows through control winding B. The output of the B core is therefore reduced and the output of the A core drives the range motor in the direction of increased range measurement.

When the range circuits are in the TRACK mode, the ground is removed from terminal 14 and both halves of the control windings are driven by the early and late gate signals. The late signal will produce an output voltage with a phase such as to drive the motor in the direction of decreased range (300-0 miles). An early gate signal will drive the motor in the opposite (0-300 miles) direction. With equal early and late gate signals, the magnetic amplifier will be balanced and the motor will not turn.

<u>RANGE MECHANICAL MODULE</u> - 1A1A12 (refer to Overall Range Block taught in Lesson 9.4)

The range mechanical module provides the variable position d-c voltage and the phase shifted 4045.7 Hz timing signal, which are needed for operation of the Range A Module. In addition, it supplies the feedback voltage to the Range B Module and range information to the range indicator on the Control and Indicator Panel.

The motor generator is activated by the range magnetic amplifier. Through gearing, the motor generator drives the distance measuring potentiometer, the phase shift resolver and the indicator drive synchros.

The distance measuring potentiometer supplies the variable d-c voltage required by the coarse range gate in the RAM. The voltage at the center arm of the potentiometer increases with range and causes the gate produced by the coarse range gate to be moved continuously out in range in a 0 to 300 mile cycle for SEARCH. In TRACK, the center arm voltage moves the coarse range gate to maintain the ranging circuits in Track.

The 4045.7 Hz basic reference sine wave is applied to the rotor of the phase-shift resolver. The amplitude of the two outputs of the stator are proportional to the sine and cosine of the angular position of the rotor. These outputs are fed to the phase shifting network in the RAM. The output of the phase shifting network is a constant-amplitude sine wave phase shifted through an angle equal to the angular position of the phase-shift resolver rotor.

ASSIGNMENT SHEET 9.12.1A

RANGE B MODULE ANALYSIS

INTRODUCTION

The purpose of this assignment is to familiarize you with the operation and functions of the RBM within the TACAN unit. Once this is understood, the signal flow to the other modules will be easier to understand.

LESSON TOPIC LEARNING OBJECTIVES

13.1.35. Given a list of conditions of the control relays, SELECT those conditions with the following modes:

a) Search.
b) Late Track.
c) Track.
d) Memory.

13.1.36. SELECT, from a given list, the signals necessary to switch from Search to Track.

13.1.37. Given a list of statements, MATCH each of the below listed circuits with the statement which describes its operation:

a) Late Track Circuits.
b) Track Circuits.
c) Magnetic Amplifier Drive Circuits.
d) Memory Circuits.
e) Late Track Memory Circuits.

13.1.38. From a given list of statements, SELECT the one which describes the charges on C5 and C6 when tracking in RANGE RATE.

STUDY ASSIGNMENT

1. Read Information Sheet 9.12.1I.

2. Review notes on Block and Schematic Diagrams.

3. Complete Assignment Sheet 9.12.1A.

STUDY QUESTIONS

1. What are the purposes of the Range B Module?

____

____

____

2. Explain why the Mag Amplifier Driver circuits are causing th indicator to count out at a maximum speed in the SEARCH condition.

____

____

3. What relay provides the countdown ground to the RAM and when is it energized?

____

4. When K2 is deenergized, the range circuits switch from _____ to _____________.

5. A ___________ will be present at P2-D anytime there is a channel change.

6. What is the purpose of the signal referred to in question 5?

____

7. Which mag-amp driver drives the indicator from 300 miles tow 0 miles when tracking in RANGE RATE?

____

8. What is the condition of the control relays in the LATE TRAC condition?

____

9. What is necessary to cause the RBM to switch from the Search mode to the Track mode of operation?

____

____

10. If the early coincidence pulse was wider than the late coinc dence pulse into the RBM, the charge on C5 would be _________ than the charge on C6.

11. The range circuits have a memory of ___________ because of t discharge of __________.

12. When will the charge on C5 and C6 be equal? _________________

____

JOB SHEET 9.13.1J

RANGE A MODULE ANALYSIS

INTRODUCTION:

This job sheet will provide you with guidance while performing the Range A Module lab. This lab will aid you in understanding the Range A Module operation.

ENABLING OBJECTIVES:

13.3.9. With the aid of an oscilloscope, OBSERVE waveforms at specified test points on the Range A Module, and RECORD them in the student workbook.

13.3.10. With the aid of an oscilloscope, TAKE voltage readings at specified test points, and RECORD them in the student workbook.

13.3.11. With the aid of an oscilloscope, ANALYZE the following circuits by observing the circuit inputs and outputs, and RECORD them in the student workbook:

a) Countdown Multivibrator
b) Integrator Control
c) Coarse Range Gate Multivibrator
d) Fine Range Pulse Circuit
e) Selector NAND Gate in the search mode
f) Early Gate Former
g) Late Gate Former
h) Reply Pulse Multivibrator

13.3.12. With the aid of an oscilloscope, OBSERVE the input and output of the coincidence circuits and RECORD them in the student workbook in synchrogram form.

REFERENCE: Maintenance Handbook with Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

EQUIPMENT AND MATERIALS:

1. Job Sheet 9.13.1J
2. Information Sheet 9.2.1I
3. AN/ARM-22A Radio Test Set
4. Type 453 Oscilloscope with 10:1 probe
5. 8H7 TACAN Training Device
6. Straight Slot Screwdriver

PRECAUTIONS TO BE OBSERVED:

1. No jewelry will be worn in the lab.
2. Do not place TACAN mode switch in T/R until the TACAN power supply has timed out (90 seconds).
3. Standby and Secure procedures are listed on Information Sheet 9.2.1I.
4. When extending a module, the metal lock tabs must remain down at all times.
5. No test point readings will be taken on the backside of the module.
6. 1800 V d-c in RF Module.
7. Plastic cover over the power supply must always remain down.
8. Do not check or remove any fuses.
9. Remove only the four small coax cables on the simulator, and no others.

PROCEDURE:

CAUTION: CARE MUST BE EXERCISED WHILE WORKING ON ENERGIZED CIRCUITS.

1. PRELIMINARY SETUP

   a. Ensure that equipment is turned off while removing and replacing modules to utilize the extender board.
   b. Utilize ranging system block, functional block and schematics of the RANGE "A" MODULE as necessary to complete this assignment.
   c. Set up the TACAN system bench and associated test equipment and perform an operational check.
   d. Observe waveforms as described in the following steps. When required, record waveforms, and answer the questions in the spaces provided on this job sheet.

NOTE: For the remainder of this assignment equipment will be set up as follows, unless otherwise directed;

   e. SG-317 pulse generator- pulse output selector to RANGE.
   f. SM-142 range and azimuth simulator- range selector to FIXED, FIXED RANGE TO 36 miles.
   g. Control Indicator for 8H7- MODE selector to T/R.
   h. Oscilloscope- EXT TRIG input from SUPPRESSOR OUT jack (J2) on the 8H7.

2. Countdown Multivibrator circuits

NOTE: Place the function selector on the signal generator in the CW OUT position for the following waveforms.
NOTE: Place the A&B TIME DIVISION CONTROL to show one complete cycle of the waveform being observed.

a. Pulse former AR1

(1) Observe and record the waveforms in the spaces below.

(a) Input to AR1 at J1-16 on RDM (1A1A1).

(b) Extend Range A Module.

(c) Output from AR1 at pin 10 on RAM.

(2) **What is the purpose of the signal observed at the output of AR1?**

b. Astable Timing Oscillator

(1) Observe and record the waveforms in the spaces pro- vided below.

(a) Pin 5 of AR2.

NOTE: Adjust Time/Div control until correct signal is observed.

(b) Output of AR2 at J1-10.

NOTE: Place function selector on the signal generator in the PUL OUT position and observe the output of AR2 at J1-10.

(2) What caused the difference in the signal at the output of AR2 when the equipment switched from search to track?

____

____

(3) State the purpose of the astable timing oscillator.

____

____

c. Inverter AR3

(1) Observe and record the signals in the spaces provided below.

(a) Output from AR3 at pin 10.

(b) Voltage on pin 5 of AR3 (Turn Airborne unit mode and power switches OFF. Remove Q1. Turn Airborne Unit power and mode switches ON. Take reading.)

NOTE: To read this voltage, set oscilloscope to INT TRIG and sweep mode to AUTO TRIG. Return oscilloscope to normal settings after reading voltage.

________________________ V d-c

(2) Answer the questions below. (Turn Airborne Unit mode and power switches OFF. Replace Q1. Turn Airborne unit power and mode switches ON.)

(a) The change in voltage at pin 5 of AR3 simulates what?

____

(b) What is the purpose of this change?

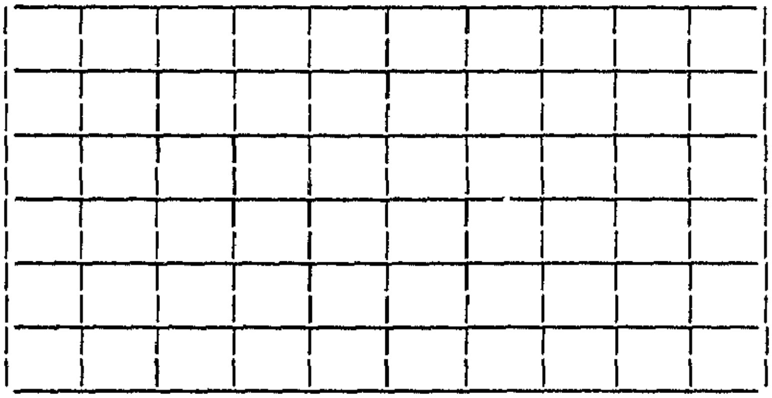
____

____

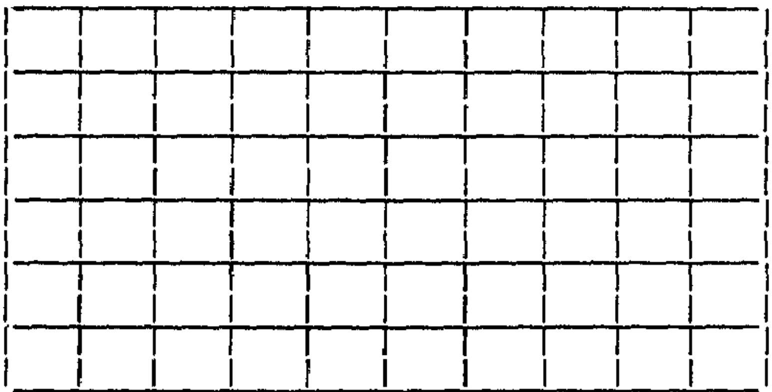
d. Trigger Q2

(1) Observe and record the waveforms in spaces provided below.

(a) Input to Q2 at the junction of R23 and C7.



(b) Output of Q2 at J1-2.



(2) What portion of the astable timing oscillator output triggers this signal?

____

NOTE: Adjust the A&B TIME DIVISION control so that the RANGE REPLY at (1A1A1) J1-3 is in the approximate center of the sweep.

a. Flip-Flop (U2A & U2B)

(1) Observe and record the following waveform in the space below.

(a) Pin 5 of U2B.

(b) What is the purpose of the flip-flop? __________

____

____

b. Inverter AR4

(1) Observe the output of AR4 at J1-7 and record the waveform in the space provided below.

(2) Place the function selector switch on the signal generator in the CW OUT position until the range circuits go into search. Then return it to the PULSE OUT position.

(3) Observe signal at the output of AR4 in a search condition.

(4) What is the output of AR4 used for? ____________

____

(5) What is the output of AR4 doing in search?

____

c. Integrator AR5

(1) Observe output from AR5 at J1-5 and record the waveform in the space provided.

(2) Place the function selector switch on the signal generator to the CW OUT position until the range circuits go into search, then return it to the PULSE OUT position.

(3) Observe the output from AR5 and answer the following questions.

What is the purpose of Q3 in the integrator circuit?

____

the purpose of the output from AR5?

____

(1) Observe the output of AR6 at J1-6 and record the waveform in the space provided.

(2) List the two purposes of AR6's output. ____________

____

e. 190 μsec one-shot AR7

(1) Observe output of AR7 at J1-9 and record the waveform in the space provided.

4. Selector NAND Gate U2C's Logic

a. Fine range pulse amplifier AR8 .

(1) Observe the output from AR8 at pin 10 and record the waveform in the space provided.

(2) Observe the input to AR1 at pin 4, change range on range and azimuth simulator to 90 miles. Observe the input to AR1 and the output of AR8 until the TACAN locks on to the new range and answer the following question. Return range to 36 miles.

Describe the operation which causes the difference in the waveforms observed? ______________________

____

____

NOTE: Observe & Record the following signals, in synchrogram form, on the DATA SHEET (steps b,c,&d)

b. Fine range pulse generator AR9's input to U2C

(1) Observe the output of AR9 at J1-3 and record the waveform in the space provided.

space provided.

d. Observe & record the output of U2C in the space provided below.

(1) Output of U2C at pin 8.

(2) Assuming the equipment is in a search mode, what would be occurring at the output of the NAND gate?

5. Gate Formers AR10 and AR11

a. Late Gate Former AR10

(1) Observe and record the output of AR10 at J1-13 in the space provided below.

(2) What is the purpose of the output from AR10?

____

____

b. Early Gate Former AR11

(1) Observe & record the output of AR11 at J1-14 in the space provided.

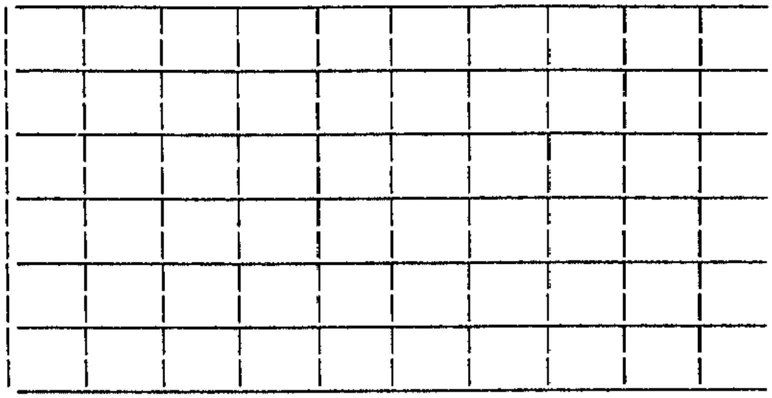
(2) What determines the pulse width of the output?

____

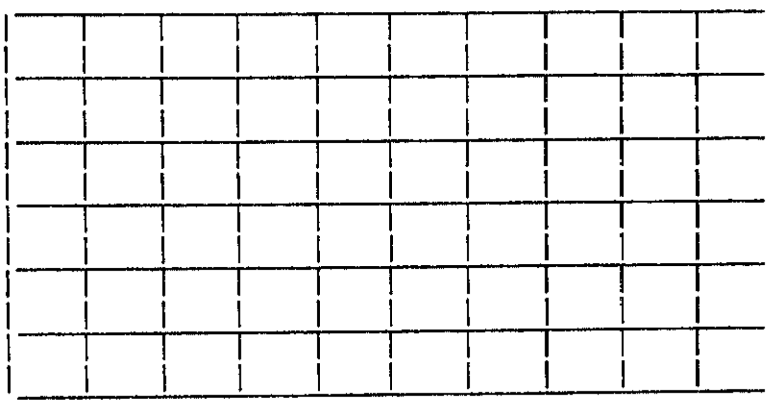
____

'-- Multivibrator
· record
t to AR12 at J1-12 on the RDM (1A1A1).

reply at J1-3 (RDM) is in the approximate center of the sweep.



(2) Output of AR12 at J1-8.

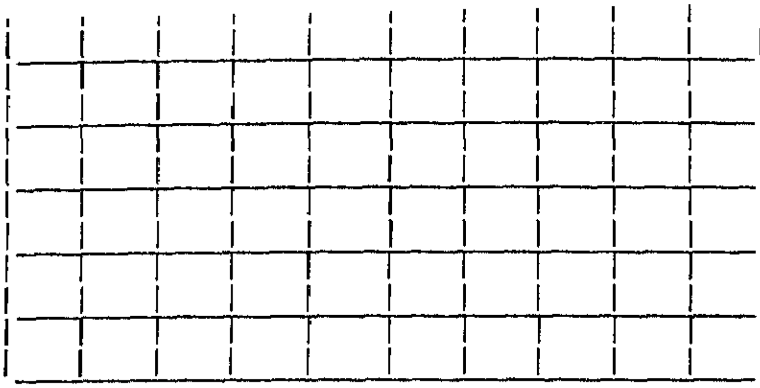


(3) Where is the output from AR12 applied? ______________

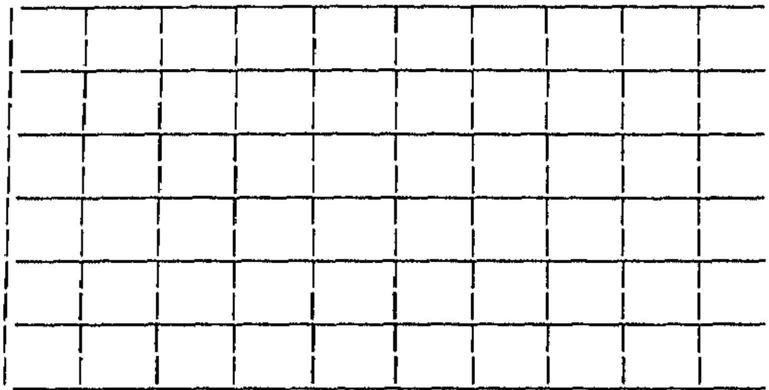
____

____

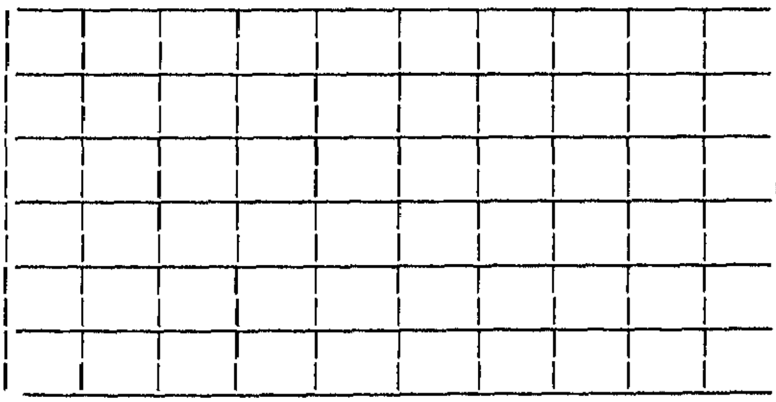
7. Coincidence Circuits Logic
   a. Observe and record in the spaces provided below. (Record in synchrogram form)
      (1) Pin 3, U1A.

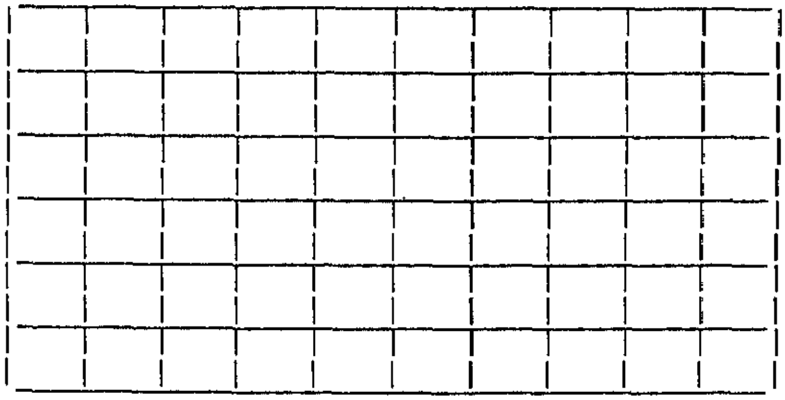


(2) J1-16

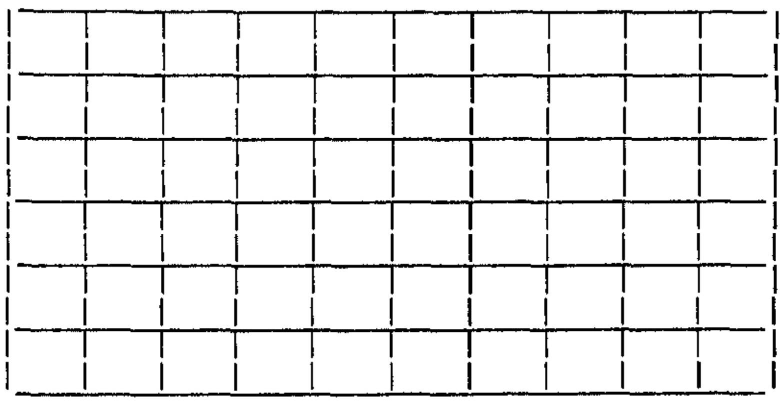


(3) Pin 11, U1D





(5) J1-15



(6) What circuit prevents a late coincidence output during early coincidence time?

8. This completes the RANGE "A" MODULE assignment. Secure your position by referring to TURN-OFF procedure in Information Sheet 9.2.1I.

   a. Turn in workbook for grading.

   b. Ask questions about confusing material.

RANGE B MODULE ANALYSIS

INTRODUCTION:

This job sheet will provide you with guidance while performing the Range B Module lab. This lab will aid you in understanding the Range B Module operation.

ENABLING OBJECTIVES:

13.3.13. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the inputs and outputs of the following circuits in the Search, Late Track, Track and Memory conditions:

a) Late Coincidence
b) Early Coincidence
c) Magnetic Amplifier
d) Memory Circuits
e) Late Track Memory

13.3.14. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the signals necessary to switch from the search to the track condition.

13.3.15. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the waveforms on C5 and C6, when tracking in Range Rate.

REFERENCE: Maintenance Handbook with Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

EQUIPMENT AND MATERIALS:

1. Job Sheet 9.14.1J
2. Information Sheet 9.2.1I
3. AN/ARM-22A Radio Test Set
4. Type 453 Oscilloscope with 10:1 probe
5. 8H7 TACAN Training Device
6. Straight Slot Screwdriver

PRECAUTIONS TO BE OBSERVED:

1. No jewelry will be worn in the lab.
2. Do not place TACAN mode switch in T/R until the TACAN power supply has timed out (90 seconds).
3. Standby and Secure procedures are listed on Information Sheet 9.2.1I.

4. When extending a module, the metal lock tabs must remain down at all times.
5. No test point readings will be taken on the backside of the module.
6. 1800 V d-c in RF Module.
7. Plastic cover over the power supply must always remain down.
8. Do not check or remove any fuses.
9. Remove only the four small coax cables on the simulator, and no others.

PROCEDURE:

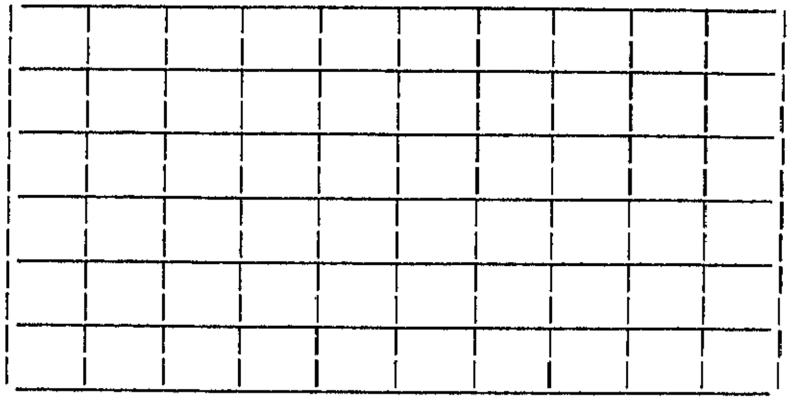
CAUTION: Care must be exercised while working on energized circuits.

1. Preliminary setup

   a. Ensure that equipment is turned off while removing and replacing modules to utilize the extender board.
   b. Utilize the ranging system block, functional block, and schematics of the RANGE "B" MODULE as necessary to complete this assignment.
   c. Set up the TACAN system and associated test equipment and perform an operational check. (Refer to 9.2.1I)
   d. Observe waveforms as described in the following steps. When required, record waveforms and answer questions in the spaces provided on this job sheet.
   e. For the remainder of this assignment the equipment will be set up as follows, unless otherwise directed.
   f. SG-317 Pulse Generator- Pulse Output Selector to RANGE.
   g. SM-142 Range And Azimuth Simulator- Range selector to FIXED, FIXED RANGE to 18 miles.
   h. Control Indicator for 8H7 - Mode selector to the T/R position.
   i. Oscilloscope - EXT TRIG input from SUPPRESSION OUT jack (j2) on 8H7. Adjust the A&B TIME/DIV control so that the range reply at (1A1A1) J1-3 is in the approximate center of the sweep.

2. Late coincidence circuits

   a. Observe and record the signals in the spaces provided.
      (1) Output from late multivibrator at J1-6.



(2) Output from AR5 at J1-8.

_______________ V d-c

(3) Voltage on collector of Q17 at J1-3.

_______________ V d-c

b. After recording signals, place equipment in search by placing function selector on signal generator in CW OUT position until the range circuits go to search and then return it to the PULSE OUT position.

c. What is the function of the late coincidence circuits during search and track?

____

____

3. Track coincidence circuits
   a. Observe and record the signals in the spaces provided.
      (1) Output from early multivibrator at J1-7.

(2) Output from track and gate at cathode of CR14 or CR15.

(3) Output from AR6 at pin 10.

____________________ V d-c

(4) Voltage on collector of Q18 at J1-2.

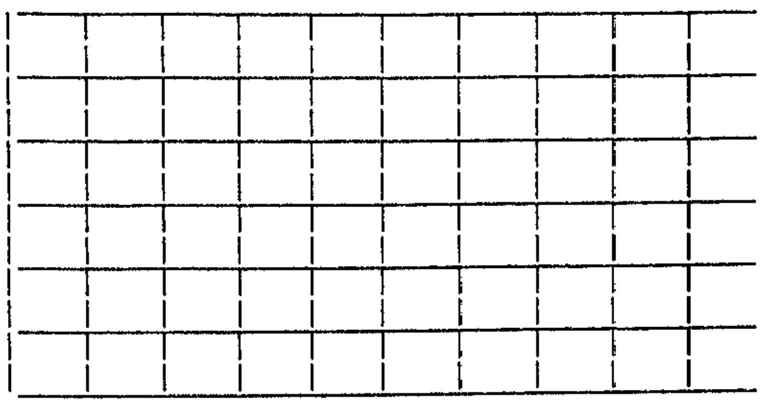
____________________ V d-c

b. What is the purpose of the track AND Gate? ______________

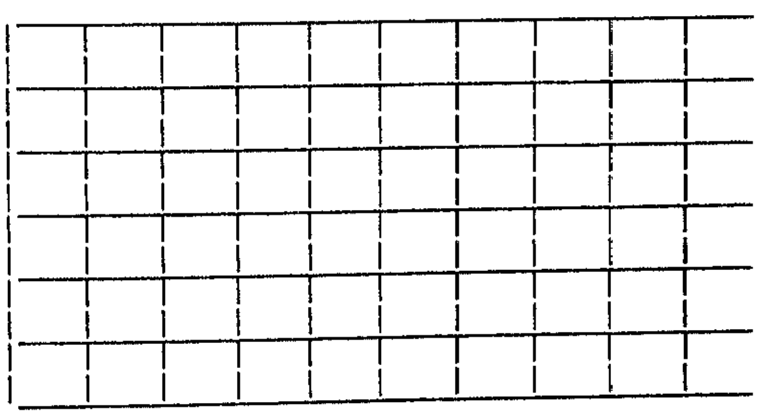
____

____

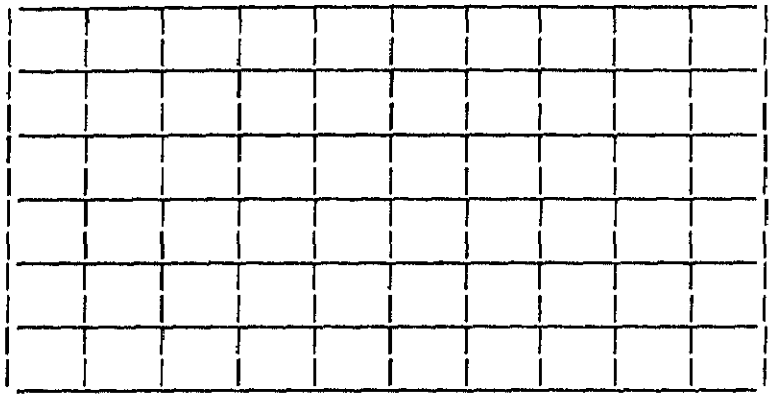
4. Early and Late coincidence amplifiers
   a. Observe and record the signals in the spaces provided.
      (1) Output from Q3 at J1-4.



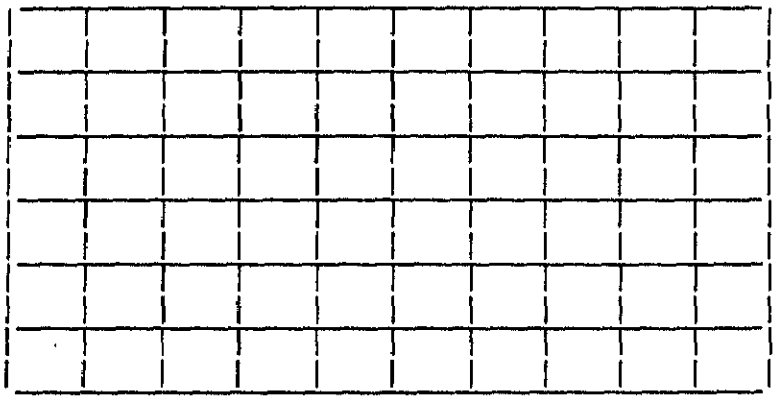
      (2) Output from Q4 at J1-5.



(3) Output from Q7 at J1-12.



(4) Output from Q8 at J1-13.



NOTE: Compare these signals

(5) Charge on C5.

__________________ V d-c

(6) Charge on C6.

__________________ V d-c

b. After recording these charges, place range selector on the range and azimuth simulator in the range rate, 0-50 position; place range rate control about mid-range, observe charges on both C5 and C6 while tracking in range rate.

c. Explain the voltages observed on C5 and C6 while the equipment was tracking in range rate.

____

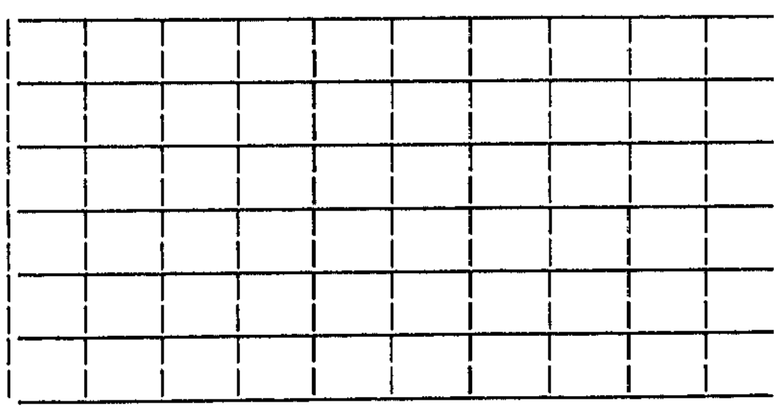
____

____

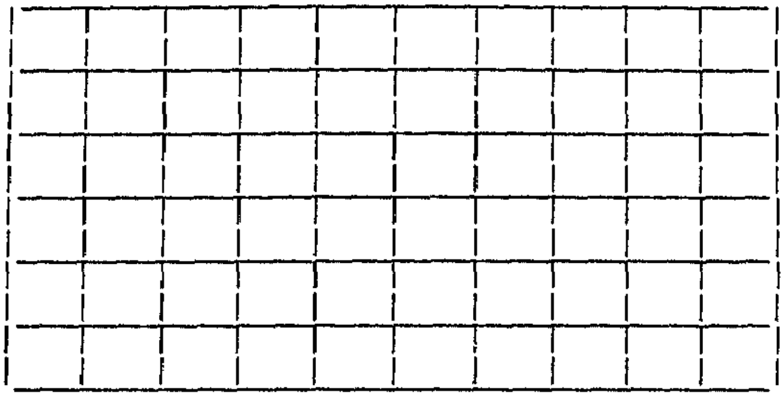
d. What determines the charge on C5 and C6 in track?

____

5. Magnetic amplifier control circuits
   a. Observe and record the signals in the spaces provided.
      (1) Output from AR1 at J1-16.



(2) Output from AR2 at J1-14.



b. What is the purpose of the signals at J1-14 and J1-16?

____

6. Memory circuits

a. Observe and record the voltages in the spaces below.

(1) Output from AR7 in search at J1-10. (Function selector on signal generator in CW out position.)

____________________ V d-c

(2) Output from AR7 in track at J1-10. (Function selector on signal generator in PULSE OUT position.)

____________________ V d-c

(3) Output from AR8 in search at J1-11. (Function selector on signal generator in CW out position.)

____________________ V d-c

(4) Output from AR8 in track at J1-11. (Function selector on signal generator in PULSE OUT position).

_______________ V d-c

b. What is the memory time of AR7? ______________________________

c. When does the output from AR8 occur?

____

____

7. This completes the Range "B" Module assignment. Secure your position by referring to TURN-OFF procedure in Information Sheet No. 9.2.1I.

   a. Turn in workbook for grading.

   b. Ask questions about confusing material.

INFORMATION SHEET 9.15.1I

BEARING DECODER MODULE ANALYSIS

INTRODUCTION

The purpose of this information sheet is to familiarize you with the BEARING DECODER MODULE used in the 8H7 TACAN trainer. This information sheet will aid you in understanding the operation of the various types of circuits used in this lesson.

REFERENCE

Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

INFORMATION

The Bearing Decoder Module detects the amplitude modulation from the composite waveform, supplies a 15 Hz and 135 Hz reference square wave to the Bearing A and B Modules, respectively. Also, it generates a 15 Hz Ringing burst that is applied to the Bearing B Module.

Amplitude Modulated video from the RDM is applied to switch Q1. Q1 is an N-channel J-FET, which is statically on.

Delayed Negative Limited Video from the RDM comes in and starts charging C1. The closeness of the MRB and ARB will charge C1 up sufficiently to overcome the reference on AR1 (closeness is defined as the spacing of the pulses in the MRB and ARB). AR1 has a static output of +13 V d-c, which reverse biases CR2. When the charge on C1 overcomes the reference set on pin 4 of AR1, the output of AR1 will go to -13 V d-c. This forward biases CR2 and turns Q1 off during MRB and ARB time of the amplitude modulated video which causes the output of Q1 to be only squitters and the peak of the composite waveform. This action is referred to as the Burst Eliminator. The output of Q1 is sent to Q2 which is also an N-Channel J-FET, which is statically OFF. Q3 is an NPN transistor and is statically ON, Q2, Q3, and C3 make up the Peak Detector. Delayed negative limited video is applied to Q3 turning it OFF and turning Q2 ON during the positive peaks of the input waveform. C3 will charge to the peak of each of the pulses out of Q2. The charge on C3 will be amplified by AR2, which is an operational amplifier, and can be seen at J1-6. The signal coming out of AR2 is called Peak Rider and is sent to the BAM and BBM to develop the two required variable signals for bearing information.

Delayed negative limited video is also applied to Q5, Q6, Q7 (27 μsec. MVB), which gives an output of a positive 27 μsec gate for every MRB pulse present at the input. Q5 in the MVB ensures that the 27 μsec gate has a sharp trailing edge. The trailing edge of the 27 μsec gate then triggers the 6 μsec MVB made up of Q8 and Q9. The output will be twelve 6 μsec pulses, its leading edge has been delayed by 27 μsecs since the input at Q7, and its trailing edge has been delayed a total of 33 μsecs since the input at Q7 (refer to figure 1). The output of Q8 and Q9 is applied to CR8.

Delayed negative limited video is applied to Q4 which is used as an inverter. The output of Q4 is positive going pulses and is applied to CR9. CR8 and CR9 make up an AND gate. The output of the AND gate is applied to pin 4 of AR4.

The 15 Hz unprocessed modulation from the BAM is applied to CR4, which rectifies the signal and passes the positive portion to a filter which develops a +d-c voltage. This voltage is applied to AR3, the Reliability Amplifier, which checks for 5% modulation of the 15 Hz signal. If the voltage at pin 5 exceeds 5% of the input signal, the output of AR3 switches from -13 V d-c to +13 V d-c. This +13 V d-c is sent across R19, R18, and R20 which develops +1 V d-c and is applied to pin 5 of AR4. The only pulses to exceed this +1 V d-c reference on pin 5 are the MRB's present at pin 4. When this happens, the output of AR4 goes to -13 V d-c. This pulse is differentiated by C14 and R49. These spikes are sent to CR15 and CR12. CR12 will pass the negative spikes through to trigger Q10 and Q11, the 15 Hz reference MVB. The output will be a 15 Hz balanced reference square wave. This signal is sent to the BAM and down to C17 and R55 which differentiates the square wave. CR13 passes the positive through and is sent to the BBM as the 15 Hz Ringing Burst used to aid in establishing 40 degree coincidence.

Delayed negative limited video is also applied to the 135 Hz tuned oscillator Q12. Components L1, R12, and C20 are tuned to 83.3 kHz, or the 12 μsec. PRT at the ARB pulses. Q12 will allow only the ARB's to pass through, since the pulse spacing of a decoded ARB is 12 μsecs. The ARB's are applied to AR5, the Auxillary Burst Identifier. When the ARB's on pin 4 exceed the reference on pin 5 the output will switch from +13 V d-c to -13 V d-c to transform the ARB's into small square waves. The square waves are differentiated across C22 and R67 and the spikes are applied to the cathode of CR16.

CR15 and CR16 make up an OR gate, and will pass the negative spikes on to Q13 and Q14. The purpose of sending the MRB down to CR15 was to synchronize the 135 Hz signal to 15 Hz, and to fill in for the MRB time so that the output of Q13 and Q14 will be a balanced 135 Hz reference square wave. This can be seen at J1-16. The 135 Hz reference square wave is sent to the BBM.

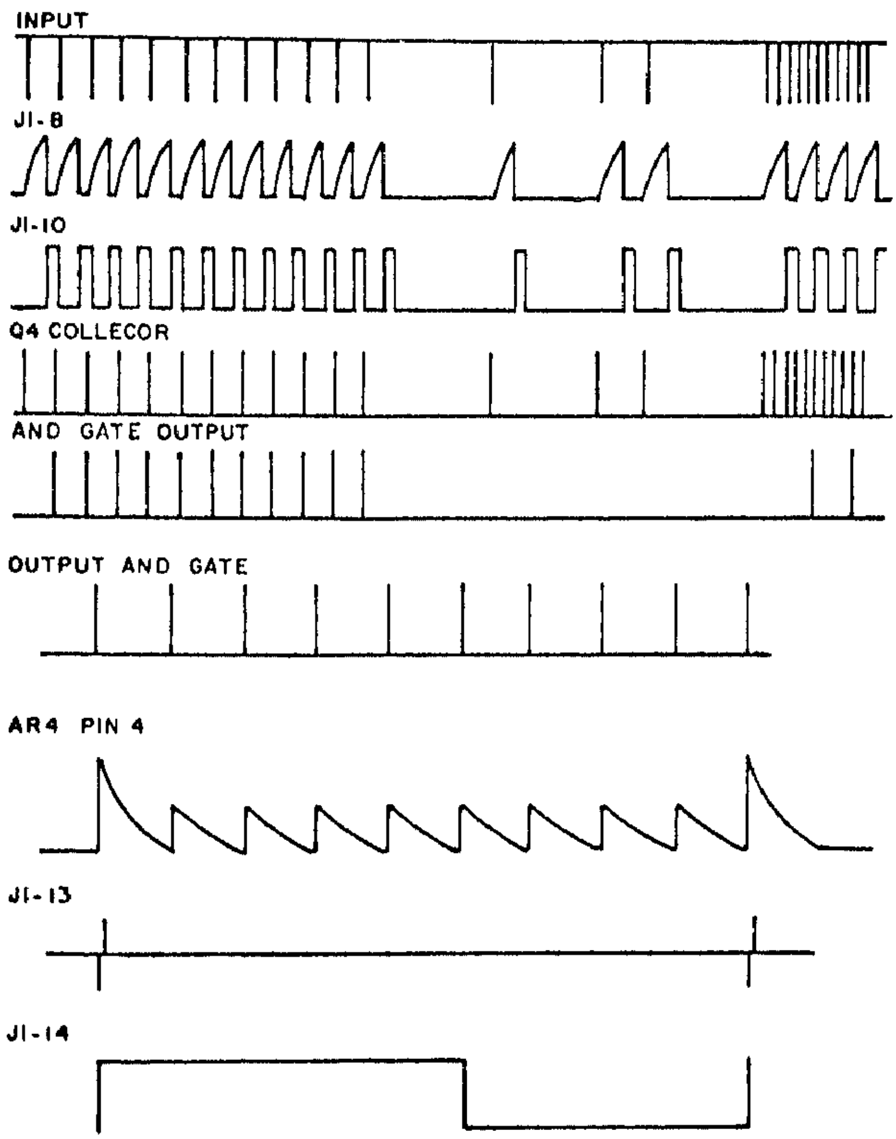


Figure 1 - MRB Detection

ASSIGNMENT SHEET 9.15.1A

BEARING DECODER MODULE ANALYSIS

INTRODUCTION

The purpose of this assignment is to familiarize you with the BEARING DECODER MODULE used in the 8H7 TACAN trainer.

LESSON TOPIC LEARNING OBJECTIVES

13.1.39. SELECT, from a given list, the statement which describes the operation of the Burst Eliminator.

13.1.40. SELECT, from a given list, the statement which describes the operation of the Peak Detector.

13.1.41. SELECT, from a given list, the statement which describes the operation of the circuits used to detect the North Burst.

13.1.42. SELECT, from a given list, the statement which describes the operation of the circuits used to detect the Auxillary Burst.

13.1.43. SELECT, from a given list, the purpose of the input on pin 5 of AR4.

STUDY ASSIGNMENT

1. Complete Assignment Sheet 9.15.1A.

2. Read Information Sheet 9.15.1I.

3. Review notes on Block and Schematic Diagrams.

STUDY QUESTIONS

1. The output of AR5, the AUXILARY BURST IDENTIFIER is

   a. a 83.3 kHz sine wave.
   b. 11 pulses, 12 μsec. apart.
   c. 8 pulses for every antenna revolution.
   d. 12 pulses, 30 μsec. apart.

2. The input to Q12, the AUXILARY BURST DETECTOR is

   a. 12 pulses, 12 μsec. apart.
   b. 11 pulses, 30 μsec. apart.
   c. negative limited video.
   d. delayed negative limited video.

3. The static condition of Q1 and Q2 is

   a. Q1 and Q2 both ON.
   b. Q1 and Q2 both OFF.
   c. Q1 ON and Q2 OFF.
   d. Q1 OFF and Q2 ON.

4. The purpose of sending the AR4 output to Q14 is

   a. to disable the 135 Hz Reference MVB during the time of a North Burst.
   b. synchronize the 135 Hz Reference MVB to the 15 Hz reference signal.
   c. trigger the 15 Hz reference MVB during the time of an MRB.
   d. to qualify the AND gate made up of CR15 and CR16.

5. The purpose of the Burst Eliminator is it removes the

   a. MRB and the ARB's, leaving the squitters and the peaks of the composite waveform.
   b. squitters only.
   c. MRB only.
   d. peak of the composite waveform only.

6. What components in the 135 Hz Tuned Oscillator are tuned to 83.3 kHz?

   a. L1, C21, R63
   b. L1, R62, C20
   c. L2, R61, C18
   d. L1, R59, C20

7. If the modulation of the 15 Hz signal drops below 5%, the output of AR3 will be

   a. +1 V d-c
   b. -13 V d-c
   c. 4045.7 Hz square wave.
   d. -1 V d-c

What is the purpose of the Bearing Decoder Module?

What is the purpose of Q5?

BEARING A & B MODULE ANALYSIS

INTRODUCTION

The purpose of this information sheet is to aid you in understanding the operation of the Bearing A & B Modules. The Bearing A&B Modules take the signals developed in the BDM, to eventually drive the indicator to ± 2/9 of a degree.

REFERENCE

Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

INFORMATION

BEARING A MODULE 1A1A5

The bearing A module provides error signals to magnetic amplifier control windings in the bearing mechanical module, and generates 15 Hz split phase (+/- sine) that is applied to a sine-cosine potentiometer, also located in the bearing mechanical module.

Two 135 Hz inputs from the bearing mechanical module are applied to a 135 Hz summing amplifier. The 135 Hz resolver outputs fed through capacitor C1 and resistor R1 are summed by operational amplifier AR1. Capacitor C2 in the feedback circuit provides necessary phase shift to maintain bearing circuit accuracy. The output at pin 10 is applied to 135 Hz phase comparator AR2 through resistor R4. The second input to 135 Hz phase comparator AR2 is a 135 Hz processed modulation sine wave from the Bearing B Module, connected to AR2 pin 4 through resistor R5. Both 135 Hz inputs are summed at pin 4, amplified by AR2, whose sine wave output is rectified by diode CR1, and filtered by resistor R8 and capacitor C3. The resultant d-c voltage is proportional to the phase difference of the two summed inputs. The 135 Hz processed modulation is also applied to inverting amplifier AR3 that has a gain of 1. The output at pin 10 is summed at the junction of resistors R24 and R25 with the output of AR1 and fed to a second 135 Hz phase comparator (AR4), that functions in the same manner as AR2. The rectified and filtered output is a d-c voltage proportional to the phase difference of the two inputs. When the 135 Hz processed modulation and the output of AR1 are 90 degrees out-of-phase, both phase comparator outputs are equal at approximately 6 V d-c. The outputs are applied to contacts 1 and 5 of the 135 Hz tracking relay K1. When the outputs are equal, the bearing indicator in the control and indicator panel, is either at the correct bearing indication, or 180 degrees away from the correct bearing. If the later condition exists, the system will be

unstable and drive the indicator 180 degrees around to the correct bearing.

A 135 Hz unprocessed modulation sine wave from the Bearing B Module has an amplitude that is proportional to the modulation index of the ground station signal. This input is rectified by diode CR4 and applied to the 135 Hz reliability circuit. The second reliability circuit input is the summed 135 Hz resolver outputs. These two outputs are rectified by diodes CR3 and CR4 and charge capacitors C10 and C11. Diodes CR5 and CR6 clamp C10 and C11 so the voltage can not go negative. The d-c level at C10 and C11 is applied to divider resistors R29 and R30, through R31 and R32 to -15 volts d-c. As long as the d-c level at diodes CR7 and CR8 cathodes is more positive than the reference voltage at AR5 pin 4, the output of AR5 will be positive. When the d-c level at CR7 or CR8 drops enough to forward bias the diode and the potential at AR5 pin 5 is more negative than that at pin 4, AR5 pin 10 output will switch to a negative d-c level. Diode CR9 is then reverse biased, allowing capacitor C13 to discharge through resistor R37 and Q1, to turn Q1 OFF. The emitter of Q1 is connected to one side (CR11) of a two input diode AND gate. The second input is a 40 degree coincidence signal from the Bearing B Module applied to diode CR12. When both 135 Hz reliability is established, and 40 degree coincidence exists, transistors switch Q2 base is driven positive, turning it on, and connecting ground through diode CR13 and Q2 emitter-collector to relay K1. When energized, K1 relay connects the 135 Hz comparator to magnetic amplifier drive circuits composed of transistors Q5 through Q8.

Relay K1 contacts 2 and 6 connect the comparator outputs to the base of transistors Q3 and Q6, which control the direction of the magnetic amplifier control windings. Transistor Q3 emitter drives Q4, which in turn drives Q5. The amount that Q5 conducts determines the amount of current through one magnetic amplifier control winding. When the outputs of Q5 and Q8 are equal, the magnetic amplifier control windings stop the bearing mechanical module motor at the correct bearing indication. If the outputs of Q5 and Q8 are different, the magnetic amplifier generates a voltage that is sent to the bearing mechanical module motor to drive it

When 135 Hz reliability is not established, or 40 degree coincidence does not exist, relay K1 is deenergized, disconnecting the 135 Hz phase comparator from the magnetic amplifier drive circuits, and connecting in its place the 15 Hz phase comparator. A 15 Hz reference square wave from the bearing decoder module is applied to non-inverting buffer amplifier AR7. The two outputs of AR7 are applied to the 15 Hz bandpass filter AR8 and to the search control circuit AR6, through diode CR15. In AR8, the higher frequency components of the square wave are removed and a 15 Hz sine wave, generated at its output, is fed to a 15 Hz phase comparator composed of AR9 and AR11. Additional inputs to AR9 and AR11 are the inverted (by AR10) 15 Hz phase-shifted modulation to AR9 and the noninverted 15 Hz input to AR11. The third input to both AR9 and AR11 is derived from search control comparator AR6. When the system is in Track, the output of AR6 is negative, reverse biasing CR16 and CR17. When the system is in Search, AR6 output is positive, driving AR11's output positive and AR9's negative. This condition causes a large unbalance, making the system go into Search with the motor driven at full speed. The inputs to AR6 are the 15 Hz reference square wave from the Bearing Decoder Module, and the 40 degree coincidence signal from the Bearing B Module. The purpose of AR6 is to put the system in search if the 15 Hz square wave is lost, unless the system was in track and 40 degree coincidence exists. With either input present, capacitor C16 remains charged and the output of comparator AR6 remains negative. Upon losing the 15 Hz reference square wave, AR7 causes C16 to discharge and AR6's output to become positive. If the system was in Track, 40 degree coincidence existed. C16 remains charged for a memory time period (3 to 8 seconds) controlled in the Bearing B Module, after which AR6 switches positive, driving phase comparator AR11 positive and AR9 negative. The operation of the 15 Hz phase comparator (AR9 and AR11) is the same as the 135 Hz phase comparator described previously. As AR11 becomes positive, capacitor C20 charges through diode CR19 and C19 goes to zero, the difference driving the magnetic amplifier in the direction of increasing bearing as in the search mode. The system is then in Search, with the motor being driven at full speed.

The peak rider output from bearing decoder module 1A1A4 is filtered by a 15 Hz active bandpass filter, composed of AR12 and related components, which passes the 15 Hz component of the signal and severely attenuates the 135 Hz component. The sine wave output (whose amplitude is a function of the modulation index from the test set) is filtered and slightly phase shifted by R13 and C7, and applied to comparator AR13 and to bearing decoder module 1A1A4 as 15 Hz unprocessed modulation. The square wave output of AR13 is again filtered by an active 15 Hz bandpass filter, and the output is applied to two places. One output is fed directly to the sine-cosine potentiometer as + sine. The second output is inverted by AR15 and applied to the sine-cosine potentiometer as - sine.

BEARING B MODULE 1A1A6

The Bearing B Module provides processed and unprocessed 135 Hz modulation applied to the Bearing A Module, 15 Hz phase-shifted modulation applied to the Bearing A and Bearing Decoder Modules, a 135 Hz reference sine wave applied to the Bearing Mechanical Module, a 400 Hz switched feedback to the Bearing A Module, and a 40 degree coincidence signal used in the Bearing A Module reliability circuit.

The Bearing Decoder Module peak rider output signal of composite 15 Hz and 135 Hz sine waves is applied to a 135 Hz active bandpass filter, composed of amplifier AR1 and associated components. The modulation is bandpass filtered then is again filtered and phase shifted, (by R5 and C3) and applied to comparator AR2 and to the Bearing A Module reliability circuit, as 135 Hz unprocessed modulation. The 135 Hz square wave output at AR2 pin 10 (varying between +/-13 volts d-c) is filtered by a second 135 Hz bandpass filter composed of AR3 and related components. This output from AR3 pin 10 is fed to the Bearing A Module phase comparator circuit as a 135 Hz processed modulation signal of constant amplitude.

Two inputs from the Bearing Mechanical Module are applied through R15 and C8, where they are summed in AR5. The two inputs are sine-cosine 15 Hz potentiometer outputs (resolver type outputs), which are amplified by AR5. The gain is determined by R17. A slight phase shift, used to attain a correct bearing indication, is obtained in the feedback loop by capacitor C9. The sine wave output at AR5 pin 18 is sent to the Bearing A Module, and is phase shifted by potentiometer R18 and capacitor C10. The 15 Hz phase shifted output to the bearing A module is used in the phase comparator circuits. The phase shifted output to R19, R20, and C11 causes AR6 output, at pin 10, to switch from a positive to a negative level at, or near, the positive peak of the AR5 output sine wave. Capacitor C12 differentiates this change of signal level which is rectified by diode CR3, and the negative signal triggers a 40 degree gate generator, a one-shot multivibrator. The multivibrator, composed of transistors Q2, Q3, and associated components, generates a positive pulse having approximately a 7.4 millisecond width. Potentiometer R27 controls the multivibrator RC time constant and, therefore, the output pulse width. The pulse is applied to one side (CR4) of a two input diode AND gate. A 15 Hz ringing burst, from the bearing decoder module 15 Hz square wave monostable MVB, is applied to the other diode (CR5) input. Coincidence between the two inputs indicates the bearing is within +/- 20 degrees of true bearing indication and causes transistor Q4 to turn on. A negative going pulse generated at Q4 collector is directed through diode CR7 (which is now forward biased) to trigger a multivibrator.

As long as 40 degree coincidence occurs, the multivibrator is pulsed every 66 milliseconds, and has a duty cycle of approximately 90 percent. The output at Q7 collector is a pulse of approximately 60 milliseconds. It is applied to the coincidence relay control circuit, which contains four diode legs, each having a different value resistor in series. The 60 milliseconds pulse causes capacitor C15 to charge and discharge through relay K1 to CR8, CR9, and R34 and R35. The charge and discharge time constant is a function of resistors R35 and R34, respectively. When capacitor C15 charges to a level above the reference level at AR7 pin 4, the output at pin 10 will switch from -13 V d-c to +13 V d-c, turning ON transistor switch Q1, through R14 and CR1. The ground at Q1 collector causes parallel connected relays K1 and K3 to energize. Relay K2 contacts 2 to 4 open, and 2 to 5 close, thereby changing the time constant of C1 charge and discharge. This circuit delays coincidence relay switching when 40 degree coincidence exists. During the delay, a number of coincidence pulses must be received before coincidence is verified. When relays K1 and K2 energize, memory time is affected. If coincidence is lost, a memory delay of between 0 to 8 seconds is provided, depending on the length of time coincidence was present. If coincidence existed only for a short time, a delay of less than 3 seconds is used. If coincidence existed for a longer time, such as 15 seconds, memory is held for 8 seconds.

The 40 degree coincidence output of AR7, developed across R40, R41, and CR12, is applied to the Bearing A Module reliability circuits. Relay K1 is used to switch the positive or negative tachometer feedback to the Bearing A Module. The 400 Hz tachometer feedback signal from the Bearing Mechanical Module is applied to relay K1 pin 2, and to inverting amplifier AR4, which has gain of 1. The output from pin 10, applied to K1 pin 6, is 180 degrees out-of-phase with the signal at pin 2. When relay K1 is deenergized (40 degree coincidence not present), capacitors in the Bearing A Module and capacitors C6 and C7 determine the amount of positive feedback. When 40 degree coincidence exists, the capacitors are switched out the circuit by energized relay K1, and the capacitors in the Bearing A Module determine the amount of negative feedback.

The 135 Hz reference sine wave circuit is composed of an active bandpass filter and a power transistor. The bearing decoder module 135 Hz square wave, generated by the one-shot multivibrator, is applied to a 135 Hz active bandpass filter, consisting of amplifier AR8 and associated components. In the filter feedback circuit, potentiometer R44 provides a means of adjusting the center frequency, and the phase shift relationship between the input, at pin 4, and the output, at pin 10. The output at pin 10 is applied to the base of power transistor Q5, to provide the power required to drive the resolver in the bearing mechanical module. The output at Q5 is a 135 Hz sine wave applied to the bearing mechanical module and fed back to the 135 Hz bandpass filter as feedback.

ASSIGNMENT SHEET 9.16.1A

BEARING A & B MODULE ANALYSIS

INTRODUCTION

The purpose of this assignment sheet is to aid you in understanding the Bearing A & B Module lesson.

LESSON TOPIC LEARNING OBJECTIVES

13.1.44. From a given list, MATCH each of the circuits below with the statement which describes its operation:
a) Search Control:
b) 15 Hz Phase Comparator.
c) 40 Degree Coincidence Circuits.
d) 135 Hz Reliability Circuits.
e) 135 Hz Phase Comparator.

13.1.45. From a given list, SELECT the signals necessary to switch the bearing circuits from search to 15 Hz track.

13.1.46. From a given list, SELECT the signals necessary to switch the bearing circuits from 15 Hz track to 135 Hz track.

STUDY ASSIGNMENT

1. Read Information Sheet 9.16.1I and complete the assignment below.

2. Complete Assignment Sheet 9.16.1A

STUDY QUESTIONS

1. Briefly explain the purpose of the BAM and BBM.

____

____

2. The 135 Hz resolver phase shifts the 135 Hz reference signal 360 degrees for every __________ degrees of rotation of the bearing motor.

3. The signal present at J1-10 on the BBM is a

a. 7400 μsec negative gate.
b. 7400 kHz sine wave.
c. 7400 μsec positive gate.
d. 135 Hz square wave.

4. In reference to the 135 Hz Phase Comparator, when C4 is more negative in respect to C3, the indicator will ______________.

5. Briefly explain why the indicator will turn at a maximum speed CCW with no input to the search control circuits.

____

____

____

6. If there is a good signal present at both CR11 and CR12 in the BAM, the TACAN will switch from ____________ to ____________.

7. The basic circuit configuration of the MAG AMP drivers in the BAM is ______________________________.

8. In the search condition, the TACH feedback from the BMM to the BBM is __________________, because K1 is deenergized.

9. The signal seen at J1-8 on the BBM is a
a. 15 Hz square wave.
b. 135 Hz square wave.
c. 60 millisecond positive gate.
d. 7400 μsec negative gate.

10. What is the purpose of the 40 degree coincidence circuits?

____

11. What is the purpose of the 135 Hz Phase Comparator?

____

____

____

12. The discharge time of the memory capacitor, on the BBM when K2 is energized, is ________________.

13. What is the purpose of Q5 on the BBM? ________________________

____

14. What is the purpose of CR11 and CR12? ________________________

____

15. When tracking a changing azimuth, the sine wave out of AR 10 on the BAM would be constantly ____________________________.

16. When the TACAN is locked on to a fixed bearing, the two signals present at pin 4 of AR2 would be ________ degrees out-of-phase, and the two signals present at pin 4 of AR4 would be ________ degrees out-of-phase (Reference BAM).

17. The output of AR13 on the BAM is a ______________________________.

18. The signal present at J1-4 on the BBM is a ______________________.

19. In reference to the 135 Hz reliability, what is the purpose of CR5 and CR6? ____

____

JOB SHEET 9.17.1J

BEARING DECODER MODULE ANALYSIS

INTRODUCTION:

This job sheet will provide you with guidance while performing the Bearing Decoder Module lab. This lab will aid you in your understanding of the Bearing Decoder Module operation.

ENABLING OBJECTIVES:

13.3.16. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the input and output of the burst eliminator.

13.3.17. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the input and output of the peak detector.

13.3.18. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the input and output of the circuits which detect the North burst.

13.3.19. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the input and output of the circuits which detect the Auxilary bursts.

13.3.20. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the input on pin 5 of AR4.

REFERENCE: Maintenance Handbook with Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

EQUIPMENT AND MATERIALS:

1. Job Sheet 9.17.1J
2. Information Sheet 9.2.1I
3. AN/ARM-22A Radio Test Set
4. Type 453 Oscilloscope with 10:1 probe
5. 8H7 TACAN Training Device
6. Straight Slot Screwdriver

PRECAUTIONS TO BE OBSERVED:

1. No jewelry will be worn in the lab.
2. Do not place TACAN mode switch in T/R until the TACAN power supply has timed out (90 seconds).
3. Standby and Secure procedures are listed on Information Sheet 9.2.1I.

4. When extending a module, the metal lock tabs must remain down at all times.
5. No test point readings will be taken on the backside of the module.
6. 1800 V d-c in RF Module.
7. Plastic cover over the power supply must always remain down.
8. Do not check or remove any fuses.
9. Remove only the four small coax cables on the simulator, and no others.

PROCEDURE:

CAUTION: CARE MUST BE EXERCISED WHILE WORKING ON ENERGIZED CIRCUITS.

1. <u>Preliminary setup</u>

   a. Ensure that equipment is turned off while removing and replacing modules to utilize extender board.

   b. Utilize bearing system block, functional block, and schematics of the Bearing Decoder Module as necessary to complete this assignment.

   c. Set up the TACAN system bench and associated test equipment and perform an operational check, using Information Sheet 9.2.1I.

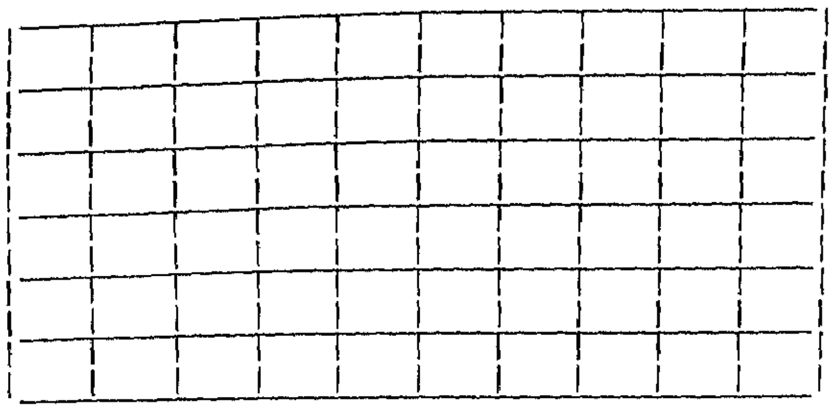
   d. Observe waveforms as described in the following steps. When required, record waveforms and answer questions in the spaces provided on this job sheet.

NOTE: All waveforms will be taken with the oscilloscope set up for one cycle of the TACAN composite waveform unless otherwise noted.

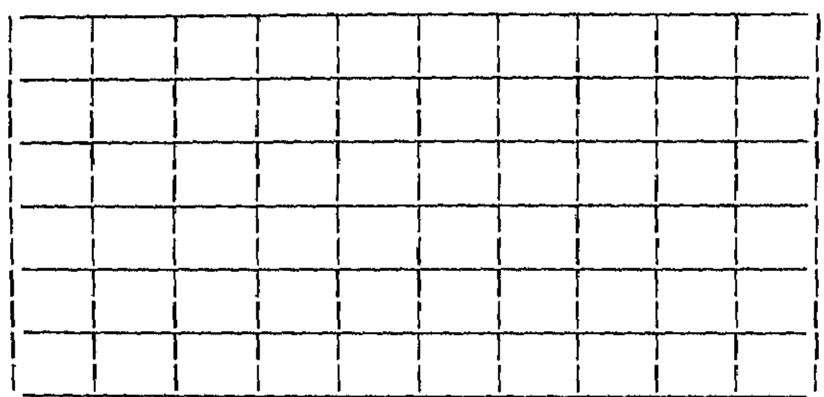
2. Detection of amplitude modulated video

   a. Observe and record the waveforms in the spaces below.

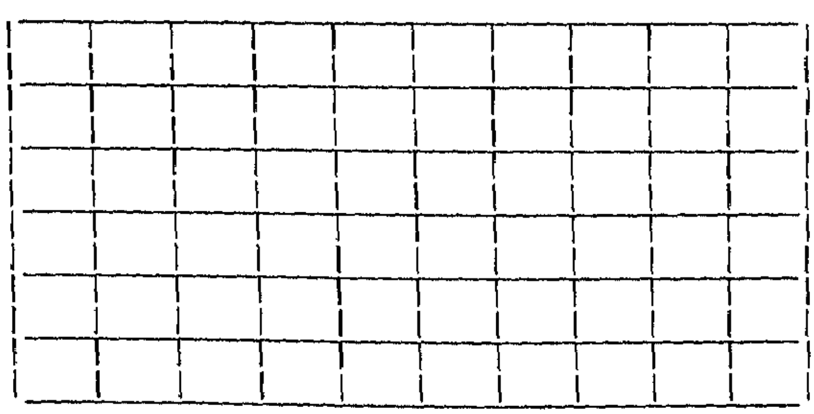
(1) Amplitude modulated video from RDM at J1-11 (1A1A1) RDM.



(2) Delayed Negative Limited Video from RDM at J1-10 (1A1A1) RDM.



(3) Peak rider output at J1-6. (BDM)



b. Answer the questions below.

(1) When is Q1 cut OFF? ______________________________

____

(2) When is Q2 cut ON? ______________________________

____

3. North burst detection

a. Observe and record the waveforms in the spaces below.

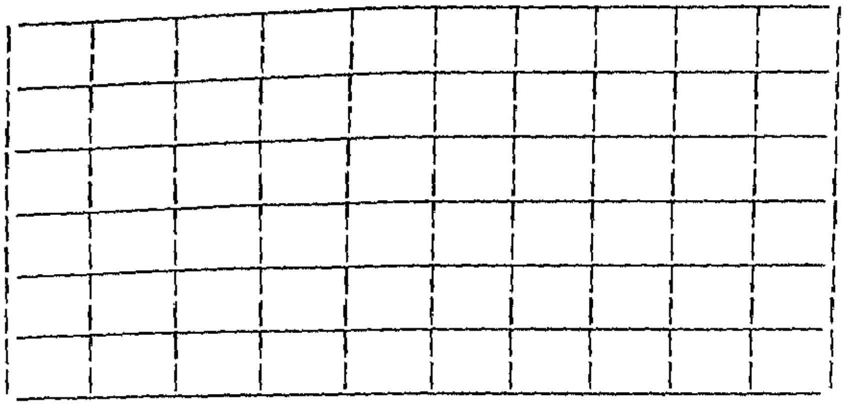
NOTE: Expand oscilloscope Time/Division to observe one MRB at J1-3 (1A1A1) RDM.

(1) 27 μsec multivibrator output at J1-8. (BDM)

(2) 6 μsec multivibrator output at J1-10.

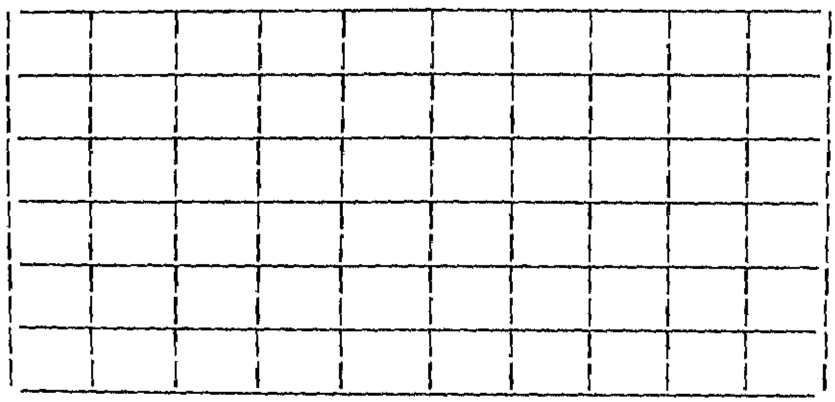
NOTE: Extend Bearing Decoder Module for remaining readings.

(3) Output of Q4 at cathode of CR9.



NOTE: Return oscilloscope sweep to observe one composite waveform.

(4) Input to AR4 to pin 4.



(5) Input to AR4 from reliability amplifier at J1-11.

____________________V d-c

(6) Output of AR4 at J1-13.

(7) Output of 15 Hz reference multivibrator at J1-14.

(8) 15 Hz ringing output at cathode of CR13.

b. Answer the questions below.

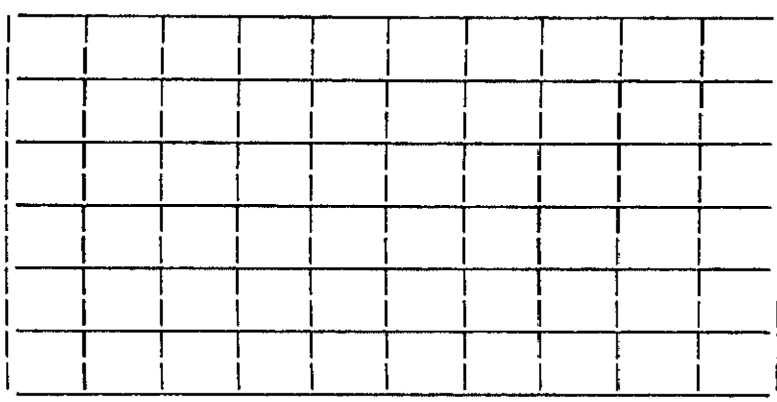
(1) Explain the purpose of the input to pin 5 of AR4.

(2) Explain the purpose of the 15 Hz ringing burst.

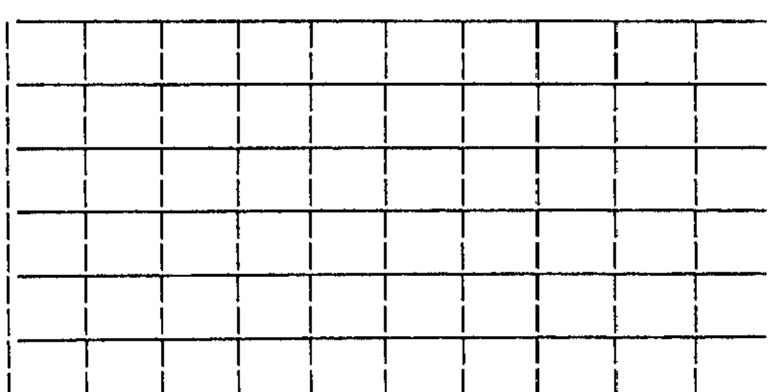
4. Auxiliary burst detection

a. Observe and record the waveforms in the spaces provided.

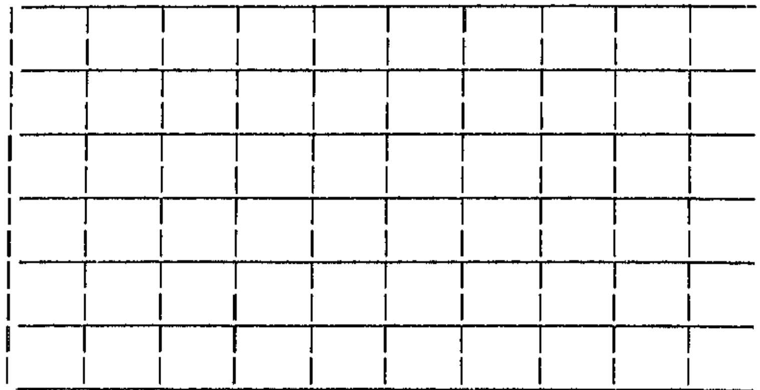
(1) Input to pin 4 of AR5.



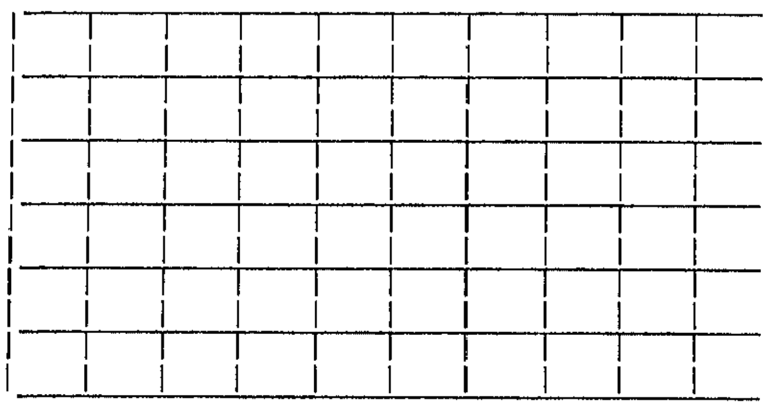
(2) Output of AR5 at the cathode of CR16.



(3) Output of AR4 at the cathode of CR15.



(4) 135 Hz reference square wave output at J1-16.



b. Answer the questions below.

(1) What frequency is the tank circuit L1, R-62 and C20 tuned to?

____

____

(2) Explain the purpose of the input from AR4 to the 135 Hz multivibrator.

____

____

5. This completes the Bearing Decoder Module assignment. Secure your position.

   a. Turn in workbook for grading.

   b. Ask questions about confusing material.

JOB SHEET 9.18.1J

BEARING A & B MODULE ANALYSIS

INTRODUCTION:

This job sheet will provide you with guidance while performing the Bearing A & B Module lab. This lab will aid you in understanding the Bearing A & B Module operation.

ENABLING OBJECTIVES:

13.3.21. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the inputs and outputs of the following circuits:
- a) Search Control
- b) 15 Hz Phase Comparator
- c) 40° Gate Generator
- d) 40° Coincidence Amplifier
- e) 135 Hz Reliability Circuits
- f) 135 Hz Phase Comparator

13.3.22. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the signals necessary to switch the bearing circuits from Search to 15 Hz Track.

13.3.23. With the aid of an oscilloscope, OBSERVE and RECORD, in the student workbook, the signals necessary to switch the bearing circuits from 15 Hz Track to Track.

REFERENCE: Maintenance Handbook with Parts List for TACAN Systems Maintenance Trainer, Device 8H7, NAVTRADEV P-3577.

EQUIPMENT AND MATERIALS:

1. Job Sheet 9.18.1J
2. Information Sheet 9.2.1I
3. AN/ARM-22A Radio Test Set
4. Type 453 Oscilloscope with 10:1 probe
5. 8H7 TACAN Training Device
6. Straight Slot Screwdriver

PRECAUTIONS TO BE OBSERVED:

1. No jewelry will be worn in the lab.
2. Do not place TACAN mode switch in T/R until the TACAN power supply has timed out (90 seconds).
3. Standby and Secure procedures are listed on Information Sheet 9.2.1I.

4. When extending a module, the metal lock tabs must remain down at all times.
5. No test point readings will be taken on the backside of the module.
6. 1800 V d-c in RF Module.
7. Plastic cover over the power supply must remain down.
8. Do not check or remove any fuses.
9. Remove only the 4 small coax cables on the simulator, and no others.

PROCEDURE:

CAUTION: CARE MUST BE EXERCISED WHILE WORKING ON ENERGIZED CIRCUITS.

1. <u>Preliminary setup</u> -

   a. Ensure that equipment is turned off before removing and replacing modules to utilize extender board.

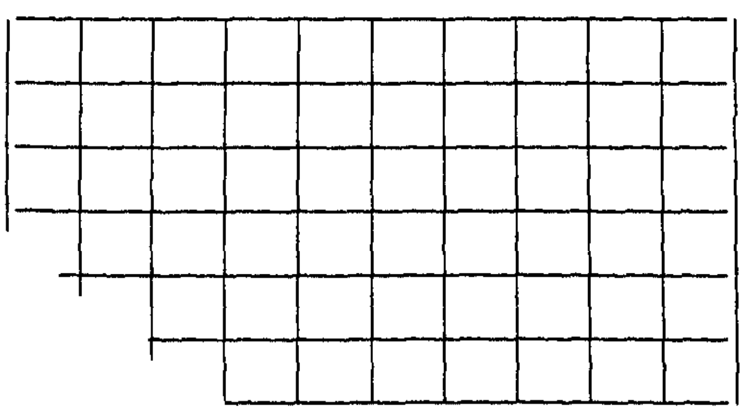
   b. Utilize bearing system block, functional block, and schematics of the Bearing A and B Modules as necessary to complete this assignment.

   c. Set up the TACAN system bench and associated test equipment and perform an operational check, using Information Sheet 9.2.1I.

   d. Observe waveforms as described in the following steps. When required, record waveforms and answer the questions in the spaces provided.

NOTE: All waveforms will be taken with the oscilloscope set for one cycle of the TACAN composite waveform unless otherwise noted.

2. 15 Hz filter and phase adjust (1A1A5-BAM).
   a. Observe the 15 Hz unprocessed signal output at J1-15 and record waveform in the space below.



3. 15 Hz filter and phase inverter (1A1A5)

a. Observe and record the waveforms in the spaces below.

(1) 15 Hz positive sine output at pin 10 of AR14.

(2) 15 Hz negative sine output at J1-16.

b. What is the purpose of the 15 Hz filter and phase inverter?

a. Observe and record the waveforms below.

(1) Input waveform at J1-9.

(2) Output waveform at J1-10.

b. Describe each of the waveforms observed.

J1-9 ____

J1-10 ____

5. 40 degree coincidence (1A1A6)

a. Observe and record signals below.

(1) D-c voltage out in track at J1-7.

__________ V d-c

OFF).

_______________ V d-c

b. What is the purpose of the 40° coincidence circuit?

____

____

c. Turn 15 Hz switch ON.

6. Search control (1A1A5-BAM).
   a. Observe and record the signals listed below.
      (1) D-c voltage out in track at J1-12.

_______________ V d-c

      (2) D-c voltage out in search at J1-12 (change channels on control box to channel 126. Wait for voltage change and record voltage below. Return channel selector to original channel.

_______________ V d-c

   b. What is the purpose of the search control? (AR-6).

____

7. 15 Hz phase comparator (1A1A5)
   a. Observe and record the waveforms listed below.
      (1) 15 Hz phase shifted input from the BBM at R42, input side (next to AR5).

(2) 15 Hz phase shifted output of AR10 at pin 10.

(3) 15 Hz processed waveform out of AR8 at J1-14.

(4) D-c voltage out at J1-6 and J1-8 in Track.

J1-6 __________ V d-c, J1-8 ________ V d-c (Track)

(5) D-c voltage out at J1-6 and J1-8 in Search (15 Hz OFF).

J1-6 __________ V d-c, J1-8 ________ V d-c (Search)

b. Explain the use of the 15 Hz phase comparator.

____

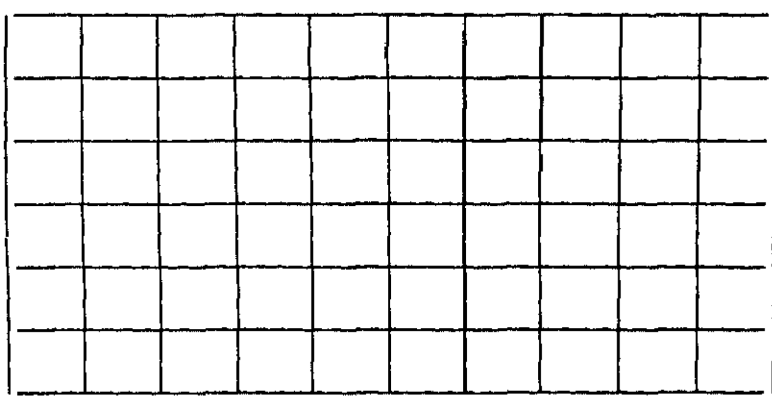
____

c. Where will the 15 Hz comparator output be applied?

____

d. Turn 15 Hz switch ON.

8. 135 Hz filter and phase adjust (AR1 on 1A1A6-BBM).
a. Observe and record the 135 Hz signal output at J1-3.



b. Where will the output of AR-1 be applied and what will it be used for?

____

____

9. 135 Hz amplifier Q5 (1A1A6)

a. Observe and record the 135 Hz output at J1-2.

b. Where, and for what reason is the output of the 135 Hz amplifier Q5 applied?

____

____

10. 135 Hz summing amplifier AR1 (1A1A5-BAM).

a. Observe and record the output of AR1 at J1-7.

b. What is the purpose of applying the phase shifted 135 Hz to the reliability amplifier? (AR5-BAM)

____

____

11. AND gate (1A1A5-BAM).

a. Observe and record the following voltages.

(1) D-c voltage on CR11 cathode in track.

______________________ d-c CR11 (Track)

(2) D-c voltage on CR11 cathode in search (change channels on control box, observe change, record voltage, then return to original channel).

______________________ d-c CR11 (Search)

(3) D-c voltage on CR12 cathode in track.

______________________ d-c CR12 (Track)

(4) D-c voltage on CR12 cathode in search (change channels on control box, observe change, record voltage, then return to original channel).

______________________ d-c CR12 (Search)

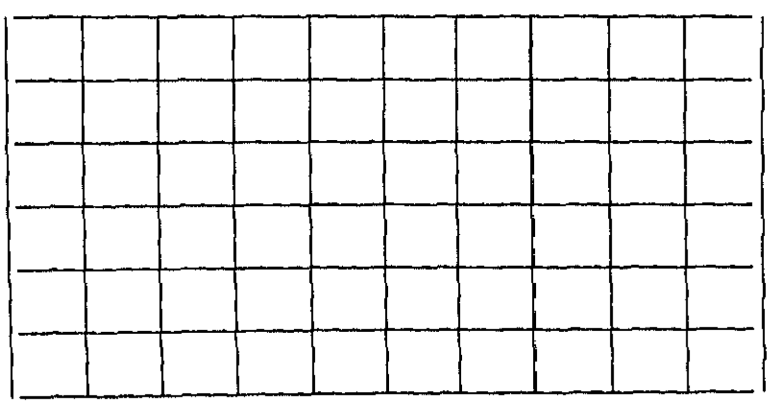
b. State the purpose of the AND gate (CR11-CR12).____________

____

2. 135 Hz phase comparator (1A1A5)

a. Observe and record the following waveforms.

(1) 135 Hz phase shifted at J1-7.



(2) 135 Hz processed modulation input to AR2 at R5 input (right-hand) side.

(3) 135 Hz processed modulation output of AR3 at R25 input (left-hand) side.

(4) D-c voltage at J1-3 in 135 Hz track.

________________ V d-c

(5) D-c voltage at J1-3 in 15 Hz track (AUX burst switch OFF).

________________ V d-c

(6) D-c voltage at J1-4 in 135 Hz track. (AUX burst switch ON).

_______________ V d-c

(7) D-c voltage at J1-4 in 15 Hz track (AUX burst switch OFF).

_______________ V d-c

b. State the purpose of the 135 Hz comparators.

____

____

____

13. This completes the Bearing A and B Module assignment. Secure your position.

   a. Turn in workbook for grading.

   b. Ask questions about confusing material.

NOTETAKING SHEET 9.19.1N

TROUBLESHOOTING A TACAN UNIT

REFERENCE:

<u>Maintenance Handbook With Parts List for TACAN Systems Maintenance Trainer, Device 8H7</u>, NAVTRADEV P-3577.

NOTETAKING OUTLINE:

A. Safety and Troubleshooting procedures

1.

a.

b.

c.

d.

2.

3.

a.

b.

c.

d.

4.

5.

6.

7.

a.

b.

c.

8.

9.

a.

b.

10.

B. Data Sheet

Fill out Data Sheet 9.20.1D, figure 1 and 2, as the instructor covers each section. Use Test Point Block figures 3 and 4 when filling in part 6 of figure 2.

C. VIDS/MAF:

Fill out the VIDS/MAF, figure 5 as the instructor covers each initial.

ASSIGNMENT SHEET 9.19.1A

TROUBLESHOOTING A TACAN UNIT

INTRODUCTION

The purpose of this assignment sheet is to familiarize you with troubleshooting the various modules in the TACAN. While you are in the lab, you will troubleshoot similar problems as those listed below. It would be to your advantage to understand how each section works in the TACAN trainer and how different modules affect each other.

LESSON TOPIC LEARNING OBJECTIVES

3.3.24. OBSERVE all safety procedures while performing operational and minimum performance checks.
3.4.1. STATE, in writing, the correct procedure for troubleshooting a Range subsystem problem.
3.4.2. STATE, in writing, the correct procedure for troubleshooting a Bearing subsystem problem.
3.5.1. From a given list, SELECT the correct information and codes that are required to properly fill out Data Sheet 9.20.1D and the VIDS/MAF.

STUDY ASSIGNMENT

- Complete Assignment Sheet 9.19.1A.
- Review notes on Data Sheet 9.20.1D and VIDS/MAF.

STUDY QUESTIONS

The TACAN's range, bearing and I.D. tone is defective. A possible trouble is:

A. AR-2 RDM defective
B. AR-4 RDM defective
C. AR-7 RDM defective
D. Q-10 RDM open

The TACAN range indicator will not lock on. A possible cause is:

A. AR-8 RDM defective
B. T-1 RDM defective
C. AR-3 RDM defective
D. R-21 RDM open

3. The TACAN range indicator will not lock on, everything else is normal. A possible cause is:

   A. Q-1 RAM shorted
   B. Q-16 RBM open
   C. Q-2 RAM open
   D. 12 μsec delay line open

4. The TACAN range indicator stops on the proper range, but the range flag remains in the window. A possible cause is:

   A. AR-5 RBM defective
   B. Q-18 RBM open
   C. Q-12 RBM open
   D. AR-2 RBM defective

5. While performing an operational check, you discovered that transmitter peak power was 0 kW. A possible cause is:

   A. Q-3 RAM open
   B. AR-8 RDM defective
   C. U2C pin 8 RAM open
   D. AR-3 RAM defective

6. The TACAN bearing indicator will not lock on, constant search. A possible cause is:

   A. Q-9 RDM open
   B. AR-7 BBM defective
   C. Q-10 BDM open
   D. Q-4 BBM open

7. The bearing indicator is sectoring 40 degrees. A possible cause is:

   A. AR-4 BDM defective
   B. R-13 BAM open
   C. CR-7 BBM open
   D. Q-5 BBM open

8. The bearing indicator shows a 2 degree error. A possible cause is:

   A. AR-1 BBM defective
   B. Q-3 BBM open
   C. AR-2 BDM defective
   D. Q-5 BAM open

9. The Antenna Selector Module does not switch at the correct rate, in the Search condition. A possible cause is:

   A. R-34 ASM misadjusted
   B. C-6 ASM shorted
   C. Q-3 ASM open
   D. CR-4 ASM shorted

10. The TACAN bearing indicator is sectoring 40 degrees. A possible cause is:

   A. Q-8 BAM open
   B. AR-1 BAM defective
   C. AR-5 BBM defective
   D. none of the above

11. 90 seconds after you have applied power, you still have 6.3 Vd.c. present at TP-803 on the 1A1A15. A possible cause is:

   A. F801 defective
   B. K801 pins 4-5 open
   C. K802 pins 6-1 open
   D. Q-801 open

12. In performing an operational check, receiver sensitivity is weak. A possible cause is:

   A. Test Set AN/ARM-22A not set up correctly
   B. R-63 RDM misadjusted
   C. Defective RF module
   D. All the above

13. In process of troubleshooting, it is noted that none of the relays are ever actuated. A possible cause is:

   A. +120 V d-c supply
   B. -15 V d-c supply
   C. 1A1Q1 defective
   D. 1A1A9 defective

14. Air-to-Air operation is defective. A possible cause is:

   A. R-30 open
   B. R-34 open
   C. P1-P open
   D. P1-R open

15. TACAN range is inaccurate. A possible cause is:

A. R-61 RAM misadjusted
B. R-42 RDM open
C. Q-1 RDM shorted
D. R-15 RAM misadjusted

ADVANCED FIRST TERM AVIONICS COURSE
CLASS A1

DATA SHEET 9.20.1D

NAME________________________RATE________CLASS NO._____POS. NO._____

TITLE: TACAN TROUBLESHOOTING/PERFORMANCE TEST

NOTE: Do not go to T/R position until after first initial.

1. Visual Inspection (external connection) ( )

2. Test equipment setup ( )

   a. Radio Test Set

      (1) RF signal generator ( )

      (2) Pulse generator ( )

      (3) Range and azimuth simulator ( )

   b. Oscilloscope ( )

3. Expand and Display ____________________

Instructor initial _______________

4. Operational Check	NORMAL	ABNORMAL
a. Azimuth accuracy and tracking	______	______
b. Range accuracy and tracking	______	______
c. ID tone	______	______
d. Air-to-air simulation	______	______
e. Receiver sensitivity	______	______
f. Transmitter peak power	______	______

5. Defective Subsystem	MALFUNCTION
a. Bearing subsystem	__________________
b. Range subsystem	__________________

c. Other ____________________

Instructor initial ______________

Figure 1 - DATA SHEET 9.20.1D (Part 1)

6. Isolation of Malfunction to a Module

   a. Use schematic

   b. List all test points in sequence taken:

TEST POINT	GOOD/BAD	TEST POINT	GOOD/BAD
________	________	________	________
________	________	________	________
________	________	________	________
________	________	________	________

   c. List the defective module ____________________________

Instructor initial ______________

7. Isolation of Malfunction to a Component

   a. Extend module.

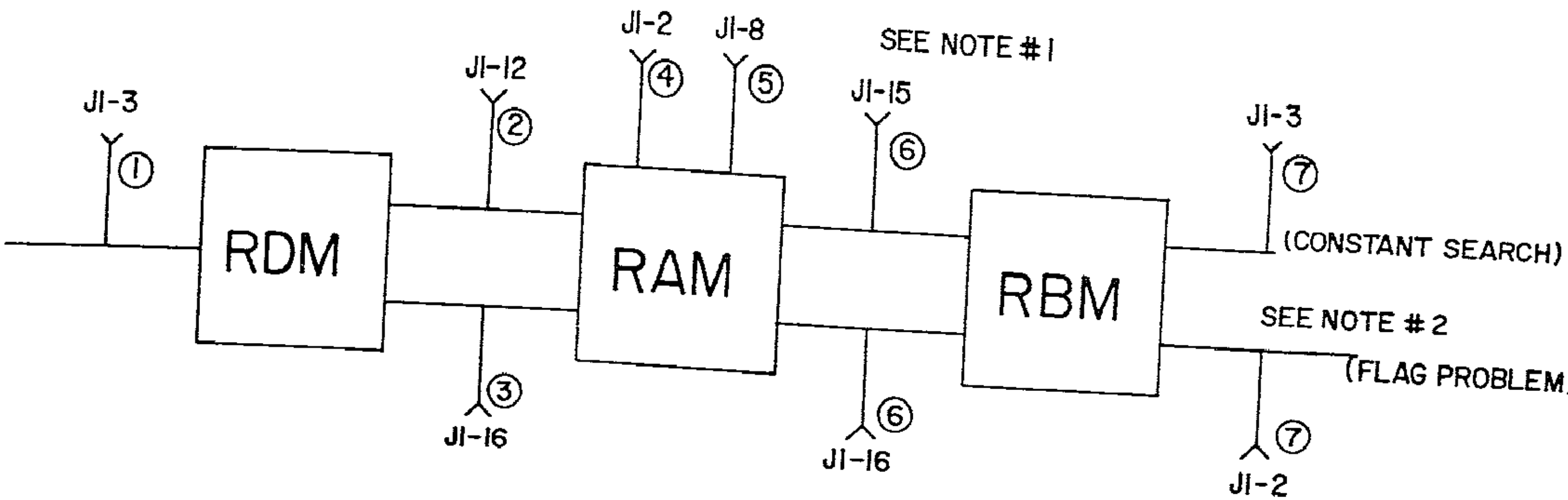
   b. List all test points in sequence taken:

TEST POINT	GOOD/BAD	TEST POINT	GOOD/BAD
________	________	________	________
________	________	________	________
________	________	________	________
________	________	________	________

   c. List the defective component _________________________

Instructor initial ______________

Figure 2 - DATA SHEET 9.20.1D (Part 2)

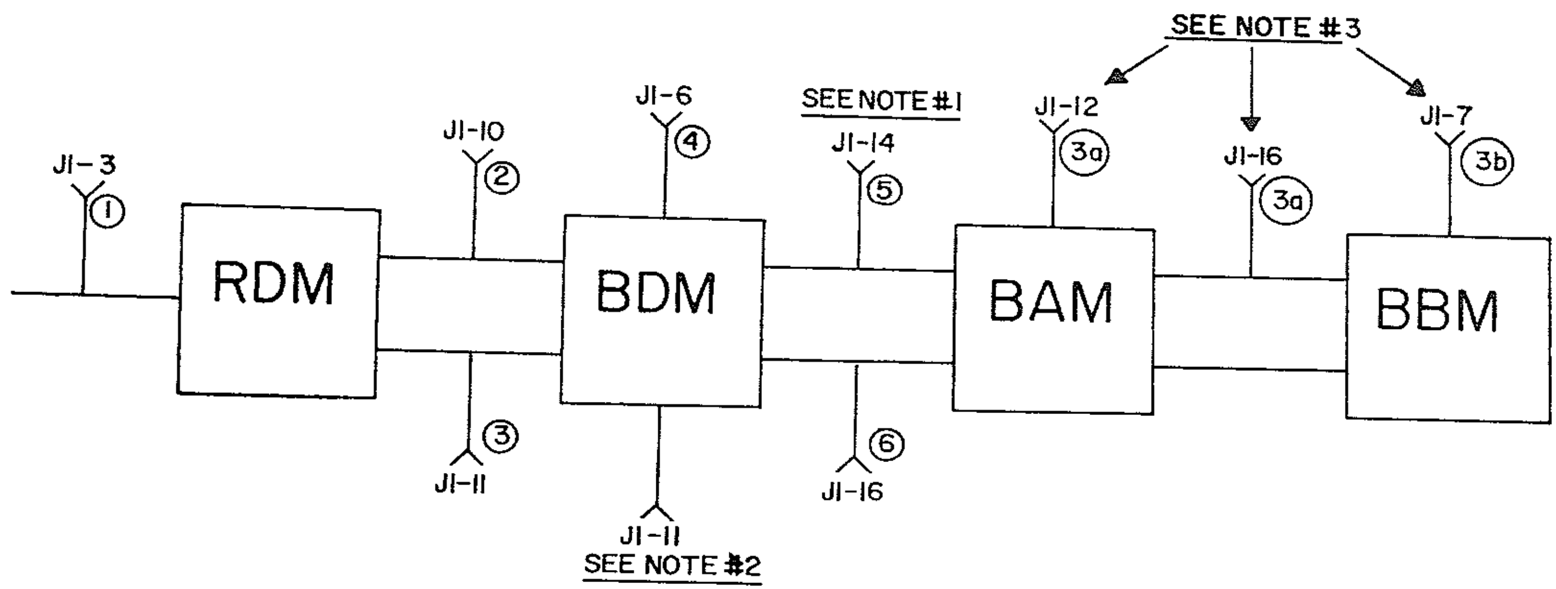


NOTE 1: MUST TAKE BOTH J1-15 AND J1-16.

NOTE 2: CHECK J1-3 IF IN CONSTANT SEARCH; CHECK J1-2 IF TROUBLE IS A FLAG PROBLEM.

Figure 3 - RANGE BLOCK

BEARING BLOCK



NOTE 1: IF J1-14 BDM IS BAD, YOU MUST TAKE J1-11 BDM.

NOTE 2: IF J1-11 BDM IS BAD, YOU MUST TAKE J1-15 BAM.

NOTE 3: (A) IF INDICATOR IS SEARCHING, CHECK J1-16 BAM; IF BAD, MODULE IS BAM; IF GOOD, CHECK J1-12 BAM.

(B) IF INDICATOR IS SECTORING 40°, CHECK J1-7 BBM.

Figure 4 - BEARING BLOCK

FOR TRAINING PURPOSES
ONLY

No.

WORK CENTER MDR VERIFICATION COPY

VIDS/MAF OPNAV 4790/60 (REV. 2 82) S/N 0107 LF 047 9304

5 PART FORM
USE BALL-POINT PEN PRESS HARD

ENTRIES REQUIRED SIGNATURE
NONE LOGS REC

LOCAL USE

REFERENCE

ACCUMULATED WORK HOURS

NAME/SHIFT	TOOL BOX	DATE	MAN HOURS	ELAPSED M/T

ACCUMULATED AWM HOURS

DATE	TIME	REASON	HOURS

(H-Z) FAILED/REQUIRED MATERIAL

79 INDEX	08 F/P	09 AWP	10 A/T	11 MAL	14 MFGR	19 PART NUMBER	34 REF SYMBOL	41 QTY	PROJ	43 PRI	46 DATE ORD	49 REQ NO	53 DATE REC

FOLD

A08 WORK UNIT CODE | A29 ACTION ORG | A32 TRANS | A34 MAINT/L | A35 ACT TAKEN | A36 MAL CODE | A39 ITEMS/P | A41 MAN HOURS | A45 ELAPSED M/T | F08 INTERIM

TECHNICAL DIRECTIVE IDENTIFICATION
F09 CODE | F11 BASIC NO | F15 RV | F16 AM | F17 PART | F19 KIT

A48 TYPE EQUIP | A52 BU/SER NUMBER | A58 DISCD | A59 T/M | A60 POSIT | A63 FID | A65 SAFETY/EI SER | A69 METER | SE MFGR | A74 | F21 | INVENTORY F22 PERM UNIT CODE | F26

REPAIR CYCLE

	DATE	TIME	EOC
RECEIVED	B08	B12	B16
IN WORK	B19	B23	B27
COMPLETED	B30	B34	

AWAITING MAINTENANCE

B38 B39 HOURS | B43 B44 HOURS | B48 B49 HOURS

MAINTENANCE/SUPPLY RECORD

JOB STATUS	DATE	TIME	EOC
B53	B54	B58	B62
B65	B66	B70	B74
C08	C09	C13	C17
C20	C21	C25	C29
C32	C33	C37	C41
C44	C45	C49	C53
C56	C57	C61	C65
D08	D09	D13	D17

JOB CONTROL NUMBER
A08 ORG | A11 DAY | A14 SER | A17 SUF | A18 WORK CENTER

REMOVED/OLD ITEM

E08 MFGR | E13 SERIAL NUMBER
E23 PART NUMBER | E38 DATE REMOVED
E42 TIME/CYCLES | E47 TIME/CYCLES | E52 TIME/CYCLES

INSTALLED/NEW ITEM

G08 MFGR | G13 SERIAL NUMBER
G23 PART NUMBER
G38 TIME/CYCLES | G43 TIME/CYCLES | G48 TIME/CYCLES

DISCREPANCY

PILOT/INITIATOR

CORRECTIVE ACTION

CF REQ | QA REQ | OFI | ECM

CORRECTED BY | INSPECTED BY | SUPERVISOR | MAINT CONTROL

UP / DOWN | MODEX | PRI | TURN IN DOCUMENT | SYSTEM/REASON | MCN

Figure 5 - VIDS/MAF

No.

WORK CENTER MDR VERIFICATION COPY

VIDS/MAF OPNAV 4790/60 (REV 2 82) S/N 0107 LF 047 9304

5 PART FORM

USE BALL-POINT PEN PRESS HARD

ENTRIES REQUIRED SIGNATURE

NONE ☐ LOGS ☐ REC ☐

LOCAL USE

REFERENCE

ACCUMULATED WORK HOURS				
NAME/SHIFT	TOOL BOX	DATE	MAN HOURS	ELAPSED M/T

ACCUMULATED AWM HOURS			
DATE	TIME	REASON	HOURS

(H Z) FAILED/REQUIRED MATERIAL

79 INDEX	08 F/P	09 AWP	10 A/T	11 MAL	14 MFGR	19 PART NUMBER	34 REF SYMBOL	41 QTY	PROJ	43 PRI	45 DATE ORD	49 REQ NO	53 DATE REC
	☐	☐											
	☐	☐											
	☐	☐											
	☐	☐											
	☐	☐											
	☐	☐											
	☐	☐											

FOLD

A12 WORK UNIT CODE | A26 ACTION ORG | A32 TRANS | A34 MAINT/L | A35 ACT TAKEN | A36 MAL CODE | A39 ITEMS/P | A41 MAN HOURS | A43 ELAPSED M/T | F06 INTERIM ☐

TECHNICAL DIRECTIVE IDENTIFICATION: F09 CODE | F11 BASIC NO | F15 RV | F16 AM | F17 PART | F19 KIT

A48 TYPE EQUIP | A52 BU/SER NUMBER | A58 DISCO | A59 T/M | A60 POSIT | A63 TIO | A65 SAFETY/EI SER | A69 METER | SE MFGR | A74 | F21 | INVENTORY F22 PERM UNIT CODE | F28

REPAIR CYCLE	DATE	TIME	EOC
RECEIVED	B08	B12	B16
IN WORK	B19	B23	B27
COMPLETED	B30	B34	

AWAITING MAINTENANCE

B38 | B39 HOURS | B43 | B44 HOURS | B48 | B49 HOURS

MAINTENANCE/SUPPLY RECORD

JOB STATUS	DATE	TIME	EOC
B53	B54	B58	B62
B65	B66	B70	B74
C08	C09	C13	C17
C20	C21	C25	C29
C32	C33	C37	C41
C44	C45	C49	C53
C56	C57	C61	C65
D08	D09	D13	D17

JOB CONTROL NUMBER

A08 ORG | A11 DAY | A14 SER | A17 SUF | A19 WORK CENTER

REMOVED/OLD ITEM

E08 MFGR | E13 SERIAL NUMBER

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INSTALLED/NEW ITEM

G08 MFGR | G13 SERIAL NUMBER

G23 PART NUMBER

G38 TIME/CYCLES | G43 TIME/CYCLES | G48 TIME/CYCLES

DISCREPANCY

PILOT/INITIATOR

CORRECTIVE ACTION

CF REQ ☐ RFI | QA REQ ☐ BCM

CORRECTED BY | INSPECTED BY | SUPERVISOR | MAINT CONTROL

UP ☐ DOWN ☐ | MODEX | PRI | TURN IN DOCUMENT | SYSTEM/REASON | MCN

180

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